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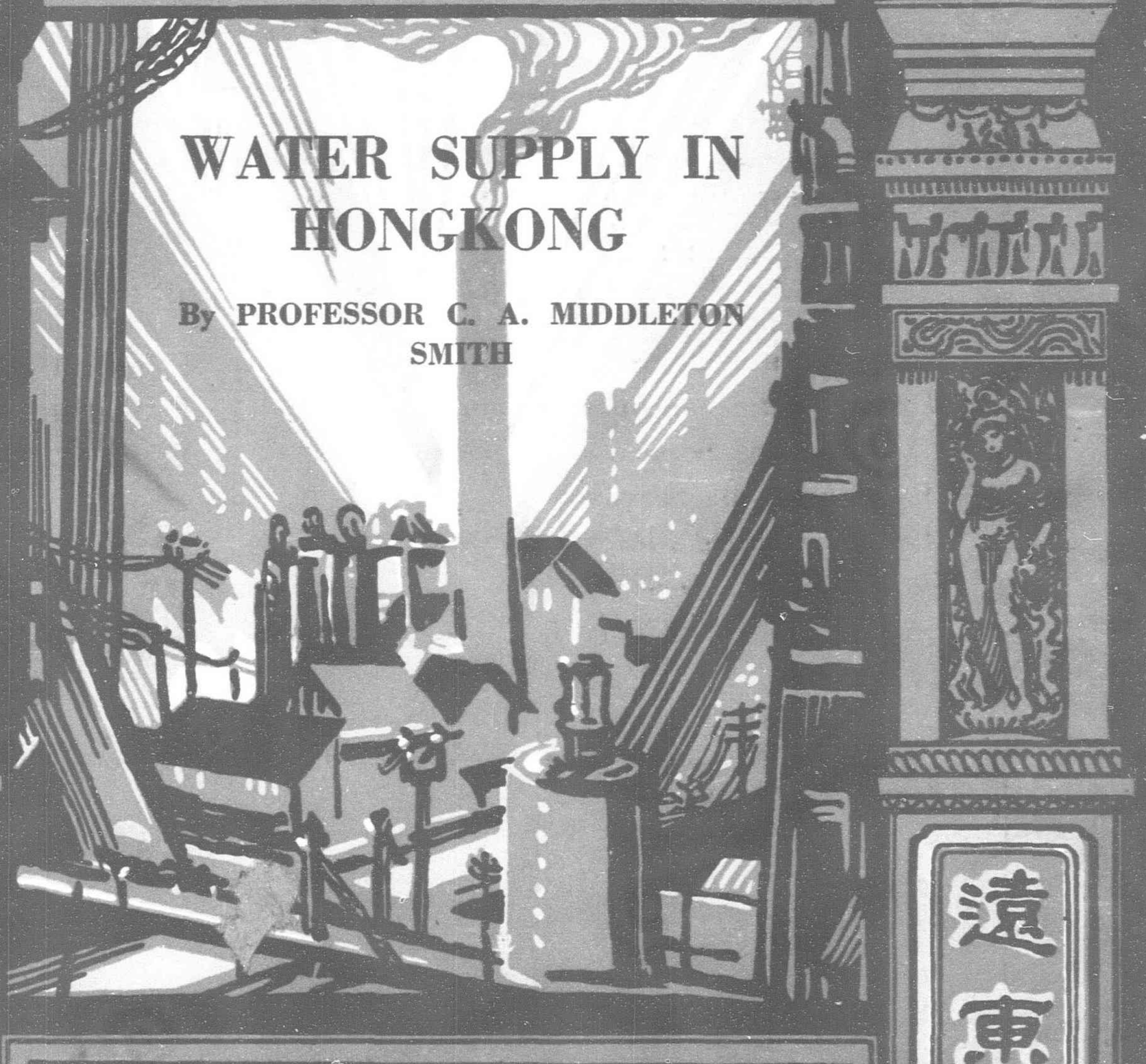

WATER SUPPLY IN HONGKONG

By PROFESSOR C. A. MIDDLETON SMITH

上海黃浦灘念四號

遠東時報

AMERICAN AND JAPANESE RELATIÓNS

PRINCIPLES OF JAPANESE DIPLOMACY

A BRITISH VIEWPOINT

Vol. XXX JULY, 1934 No. 7

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The Far Eastern Review

ENGINEERING FINANCE COMMERCE

VOL. XXX SHANGHAI, JULY, 1934 No. 7

American and Japanese Relations

By *WILLIAM R. CASTLE, Jr., Former Under Secretary of State of the United States, in "The New York Herald Tribune"*

VARIOUS more or less important recent events in the Far East have revived American interest in the Orient.

A son has been born to the Emperor and Empress of Japan, an event which must be of universal interest, at least sentimentally, since the boy will carry on what is by far the oldest Imperial line in the world.

The American press has made much of the fact that a Japanese novel dealing with the subject of an American-Japanese war was seized by customs officials in Honolulu. As might have been expected in such a book, Japan was victorious.

Finally, the United States has recognized the Soviet government of Russia, and this has incorrectly been taken by some as presaging a new alignment of interests in the western Pacific. These quite disconnected happenings make a review of our relations with the Orient pertinent at this time.

When Commodore Perry forced Japan to open its ports to the world he made a treaty with the Shogun, one of the terms of which guaranteed American support against all enemies of the Hermit Empire. Perry was a better sailor than he was diplomat and historian. He had probably never heard of entangling alliances. His treaty was quietly forgotten and the treaty of friendship and commerce negotiated by Harris, the first American diplomatic agent, a few years later made no mention of any American guaranty of the integrity of Japan. America was, nevertheless, the official introducer of Japan to the Western World and has, on the whole, been proud of her protége.

In 1860 the Orient was almost a closed book to the West. Traders, it is true, had opened pages here and there, pictured pages that suggested spices and pageantry, moguis and mandarins and opium, but there was little real knowledge of China, and none of Japan. Of the characteristics and the mentality of Oriental peoples nothing whatsoever was known. Little enough is known at the present day. That is why relations with the Far East present special problems, why it is impossible from day to day or from year to year to predict the course of events.

Americans are inclined to be a little sentimental about China, to generalize about Chinese gratitude toward the United States without having an adequate basis for the generalizations. In the days of active foreign penetration of China the United States seized no territory as concessions. It was John Hay who proclaimed and put through the policy of the Open Door, a policy which meant that no nation should be given special trade advantages at the expense of any other nation ; a policy which was a great safeguard to China because it meant that no nation could wring from the Chinese, privileges which really infringed on Chinese sovereignty.

It was Charles E. Hughes who, at the Washington Conference in 1922, negotiated the treaties by which the various nations promised to respect the territorial and administrative integrity of China. At times of flood and famine America has poured out assistance in almost unlimited amounts. As a result of these things the average American believes that all Chinese are grateful to the United States, that whatever may happen to others, Americans are safe in China.

Nothing could be more erroneous. Some Chinese are grateful ; but the vast mass of the people do not differentiate between Americans and other foreigners, and are not in the slightest degree interested in what we have done for the nation. The politicians—those who know and understand—think of past favors as an earnest of more favors in the future ; and if these favors are not forthcoming, they are merely contemptuous.

No Common Denominator

It would be wrong wholly to blame China for this attitude. The Chinese detest the condescension of western nations, and are willing to endure it only so long as they profit by it. They represent an ancient civilization which was producing magnificent works of art when our ancestors were barbarians, or at the best, nomads. The impact of the Western World on this civilization, so utterly different from ours and in many respects too much more self-contained, so much better balanced, has so far—with striking individual exceptions, of course—only created a class which adapts to Chinese uses the political trickery of the West. Furthermore, until China is criss-crossed with a network of railroads and highways it cannot be a unified nation. There is no common denominator. The North is ignorant of the South, and neither obeys the middle.

Civil war destroys any possibility of unity. Different war lords control different sections of the country and seldom pay much attention to Nanking. The revolt in Fukien was against the National government, and was ostensibly waged on the ground that the National government has not put up an effective resistance against Japan in Manchuria. This is only an excuse ; any other would have done as well.

The revolt was serious only in that it included certain of the more important Cantonese leaders who are also leaders in the dominant party, and in that it adds one more to the many disruptive forces against which Chiang Kai-shek is fighting. There was no indication that it contained the seed of a new national unity. It was only the latest manifestation of general disorganization. The government in Washington like other governments persists in the error of thinking that since the fall of the monarchy it can treat with Peiping or with Nanking as it can treat with Paris. But China is not a nation in the sense that France is a nation.

With all its protestations and evidences of friendship to China, the United States has not failed to look after its own interests. We have extraterritorial privileges like the others. Americans in China are tried in the United States court for China. We have had troops in China ever since the Boxer troubles in 1900, and it is certainly no exaggeration to say that the presence of these troops has saved many an American life.

Chinese Denounced Treaties

Before the trouble between China and Japan the Chinese were actively negotiating for the abolition of all extraterritorial treaties, and even went so far as to denounce them as of a certain date. There has, however, been no attempt to interfere with the extraterritorial rights since the date of denunciation, and the United States would be very foolish to give them up except as part of a general international arrangement.

There is a great deal of loose talk about the inquiry of extra-territorial jurisdiction as being an anachronism in this modern world, as being direct interference in national affairs and therefore contrary to the spirit of the post-war peace treaties. This is theoretically true. There seems little reason to cling to the rights in Morocco or even in Egypt. We surrendered them years ago in Japan. But in China the situation is different. When China becomes a sufficiently unified nation to enforce justice in all its parts and when the system of jurisprudence is such as to insure justice as it is understood in the Western world, including equal treatment in the courts of aliens and nationals, as is supposedly the case in all modern nations—when that time comes, the United States should join with the rest of the world in relinquishing voluntarily and gladly all extraterritorial rights. Until that time comes, doing so would be unfair to our own citizens. It would be a gesture which the Chinese would interpret as weakness, not as generosity.

Except in this matter of extraterritoriality there would seem to be no reason why relations between the United States and China should be in any way strained. China must understand, of course, that American friendship is in no sense an alliance, that while we are sincere in wishing to assist China to build herself into a strong and forward-looking nation, able to defend itself, we ourselves are not willing to act as its defenders. The American tradition of no entangling alliances must apply to the Far East as well as to Europe.

Nor should there be any danger of serious misunderstanding with Japan. After all, the interests of the United States and Japan were parallel and thoughtful Japanese must realize that over the course of years America has not been only friendly, but understanding. There have been disagreements, of course, but these same thoughtful Japanese must also realize that America has its standards, just as Japan has its standards, and that we have as much right as they to be faithful to our traditions and beliefs. The very fact that, on the whole, we have been enthusiastic friends of Japan makes the occasional disagreements stand out more prominently in Japanese eyes.

American Immigration Policy

America has always claimed that its immigration policy is solely an internal matter, that questions of quotas or even of exclusion lie solely in the hands of Congress and of the government. If we wish to exclude all immigrants we have an undoubted right to do so. If we decide to exclude, because they are dangerous to our standards or to national economy, the people of some particular nation, we have an undoubted right to do so.

But whatever right a government may have to pass this law or that, there are other criteria beside legal right which should decide action. When the Japanese exclusion law was passed nobody denied its legality, though most thinking people denied its necessity and felt that it was not in good taste. The Japanese were proving themselves dangerous competitors of native Americans in agricultural enterprises on the Pacific Coast. California was persuaded by the furious propaganda of a few newspapers that unless something were done American farmers would be driven from their holdings. The California representatives in Congress echoed these sentiments.

When the immigration laws were under consideration the Japanese Embassy sent a note to the Secretary of State protesting against the suggestion of singling out Japan for drastic action. The Ambassador used the unfortunate phrase "grave consequences" in commenting on what might happen if the act were passed. The phrase was used in its literal sense. The Senate seized on it in its diplomatic sense as a threat of war, and to prove that America could not be coerced, it promptly made Japanese exclusion a part of the law. It ignored the fact that the note was sent at the suggestion of the Department of State, but the Secretary of State himself had seen no sinister meaning in the phrase, but had taken it literally, as it was intended. So, through misunderstanding and through lack of reflection, the United States gave Japan what that country has always considered a gratuitous insult.

"But without exclusion," one hears people say, "the country would be flooded with Japanese, who would introduce lower standards of living, who would, because of this, compete unfairly with our merchants and farmers." This remark is characteristic. Actually, if Japan were on a quota basis, a maximum of some 180 persons could enter the United States annually. Will those 180 destroy the living standards of 130,000,000?

It is high time that the Congress should reconsider this action and thus heal the sore that festers the Japanese imagination.

Misinterpreted in Japan

This episode in Japanese-American relations is worth extended comment only because the action has been as much misinterpreted in Japan as Mr. Hanihara's phrase was misinterpreted in the American Congress, and for this reason has made the Japanese suspicious, has hurt their pride, has put them on the defensive. In all probability the Japanese novel about an imaginary American-Japanese conflict would never have been written had there been no irritating exclusion law. But even if it had been written nothing could be more silly than to get excited about it. Obscure American writers produce absurd and generally obscure books about the depravity of other nations, and nobody claims that they represent American opinion. The notoriety given this particular book will probably make it sell, and that is all there is to it.

A far more fundamental disagreement, because it was a disagreement in principle, came recently over the invasion of Manchuria. An attempt to explain the Japanese point of view must not be taken as condonation of recent Japanese actions in China, but simply as showing the divergence in principle between the two nations.

Americans love their country, but are quite willing to criticize it. The Japanese love their country, but brook no criticism. Patriotism is the essence of their blood, is the air they breathe. All loyalties center in the fatherland and in the Imperial Family. Therefore, anything done in the name or for the sake of the Emperor, who represents the country, is altogether right in the eyes of the mass of the people. As a theory this is wholly laudable. It makes for virility, for self-sacrifice, for devotion to a great cause. In practice it may destroy the critical faculty, in that it substitutes unthinking obedience to officials for a reasoned support of the best interests of the nation.

Conflict of Ideals

To Americans it seemed that this was what happened in the case of Manchuria. Americans were not opposed to the national aspirations of Japan for expansion of its influence, but they were eager for the preservation of the various post-war treaties; they did not like to see one friend profit by the weakness of another. Essentially it was a conflict of ideals.

The Manchurian trouble is too recent to enable us to evaluate the different steps in American policy. That mistakes were undoubtedly made is only natural and human, but there also can be no doubt that the main stream of American policy was correct. The Department of State was not unconscious of the tribulations of the Japanese in Manchuria, of the long series of unprovoked attacks on Japanese rights. It did not ignore the truth that Manchuria, because of its proximity and the fact that it must always be an indispensable source of supply to Japan, stood in a very special relationship to the Island Empire. But it did most earnestly believe that the relationship could better be advanced through peaceful measures. It deplored the dominance of the military in Japan, a dominance that meant a virtual breakdown of civil government, so far as the making of policy was concerned, that ignored any treaty obligations which, in the eyes of the army, were contrary to the immediate interests of the Empire.

The situation was difficult for the Department of State. The League of Nations had taken jurisdiction of the dispute at the beginning, but wanted the United States to co-operate. The United States was clearly involved through the terms of the Nine Power Treaty guaranteeing the political and administrative integrity of China and through the terms of the Kellogg pact renouncing war as a national policy and promising to seek peaceful settlement of disputes. Co-operation was difficult because America was determined to take no measures which might lead toward war, no measures which might make the Japanese feel that it was influencing the nations in the League to institute a drastic policy. America as a potential enemy looms large in Japanese eyes and, in the temper of the military, as illustrated by the senseless Shanghai fighting, the appearance of hostility might have led to dire results.

Looking Backward at Events

As one looks back over the kaleidoscopic events of the last two years it is very easy to criticize the separate steps taken, but it is

not easy to criticize adversely the main line of American policy. It would undoubtely have been wiser to insist at the very beginning that China and Japan institute direct conversations. But that is to look backward. At the time the world was all too ready to listen to the protestations of China that in such conversations it would have no chance. It is clear now that China would have retained a shadowy sovereignty over Manchuria, it certainly was not clear then that without such conversations China stood to lose everything.

But nobody appreciated the determination of the Japanese military leaders; nobody realized the impotence of the Japanese government in the face of the military. What the American government wanted—its only purpose in everything it did, alone or in conjunction with the League—was to preserve the post-war treaties which seemed the only indication of progress toward a stable world. Therefore, and for that reason only, America protested against the successive Japanese movements when they were clearly in contravention of the treaties—movements, in many cases, which the Japanese government had solemnly promised would not be made.

The press of the United States was far more bitter than was the Department of State, but the press was dealing in facts of the moment, was not looking ahead. The President always counseled patience. He knew that another world war was a stupid and immoral way to settle a local war.

What the future may being, or whether the state of Manchoukuo will remain, no man can say. The United States was the first to announce that it would not recognize the fruits of aggression, and it referred, primarily, of course, to the Japanese invasion of Manchuria.

It is very much to the credit of the Japanese government and suggests that a calmer spirit is abroad in the land that there was little or no excitement when the United States recognized the Russian Soviet government. The Russian government had published documents of a sensational character alleged to have been sent by the Japanese representative in Manchoukuo to his government in Tokyo. Nobody outside of Moscow knew the reason for this very provocative act. If the documents were forgeries their publication looked like an incitement to war; if they were genuine the Russians were flaunting in Japan's face the fact that the spy system was active and efficient.

President Roosevelt happened to choose the moment of publication of these documents to suggest to President Kalinin that an envoy be sent to Washington to discuss recognition. It would not have been strange if the Japanese had believed this to be a declaration that in case of war the sympathies of America would be with Russia.

Fortunately the Japanese Ambassador had already warned his government that Russian recognition was imminent. Evidently, also, the more sober people in Japan realized that the very fact of the coincidence of dates proved that the recognition had no slightest connection with the Far Eastern situation.

Russo-Japanese Relations

There is no doubt that the relations between Japan and Russia are very tense. Pessimists predict war, but if this happens the rôle of the United States can only be one of strict neutrality. If war should come—and it is certain that neither nation wants war—it will be on issues with which we have no concern. The world will urge mediation and the result will show, as nothing so far has shown, whether the Kellogg pacts and other similar treaties have the vitality to meet a real crisis.

The United States has assumed responsibilities in the Orient such as it has nowhere else. The danger of trouble with China in any forseeable future is negligible. Trouble with Japan would be a crime against civilization. Japan is intensely virile and forward looking. Its standards, to be sure, are different from ours, and beneath the veneer of Western ideas there is intense Oriental nationalism.

Japan is assimilating what it wants of Western civilization. Western ideas of legal justice, for example, have really taken root in this Oriental soil. America has never regretted giving up extra-territoriality. There is, therefore, no reason for a clash of ideas and ideals which without an earnest attempt to understand the other on the part of both nations, might lead to serious misunderstandings. In every other way the paths of the two nations lie parallel. Each needs the support and the faithful friendship of the other. For self-interest and for the support of world decency and progress each must be forebearing without surrendering its conscience or its ideals.

Principles of Japanese Diplomacy

Decision at Hague and League Makes Japan Distrust World Judgment

By M. SHIGEMITSU, Vice-Minister for Foreign Affairs and former Minister to China

(Following is an address which was given at the annual banquet of the International Association of Japan and subsequently published in the June issue of "Kokusai Chishiki," an organ of the Association.)

JAPANESE diplomatic principles, her policies towards foreign Powers, were put into a definite form when she served the notice of withdrawal from the League of Nations. She deserted the peace institution since she failed in the recent controversy to carry out what she thought necessary and justifiable for herself, although she had long lived up to a policy of international co-operation and conciliation for all problems whether they might be of a political nature or otherwise and whether they related to European or Oriental issues. Japan was compelled to take her own course of action, as since the outbreak of the Manchurian incident foreign Powers had come to disregard Japanese points of view which were considered as most important and even vital to her existence.

It permits of no contention as to what course of action Japan should pursue in the future and what she believes justifiable for herself. I note, however, that these points are not known very definitely in some cases not only in foreign countries but even in this country, and there are some who entertain some doubts or rather a suspicion towards our attitude and stand in international politics. And it is necessary, particularly at this moment, to make foreign people acquainted more definitely with our national policies, and on the other hand to make our own people understand better our position in international politics.

Japan Does Not Believe in the Judgment of the World

Commenting on our national excitement over the "emergency" as it exists at present and the "crisis" which may overtake this country in 1935, a very influential American resident here once pointed out to me that there was an excessive scare about the present hardship and possible difficulties in the future. There is no denying that an excessive excitement over the probable crisis will no doubt give birth to an impression in the minds of many foreign people that Japan is too nervous and has no conviction behind what she is doing. Japan is one of the most powerful nations in the world and is steadily making her own way in the recent world politics with great conviction and national strength. There is no necessity for her to become nervous.

Nevertheless, we cannot afford to consider the excitement as merely an outcome of some incitement made for some specific intentions, but it is rather the expression of our national sentiment which has been implanted into our minds by the many unpleasant events in the past.

As one of these events, I should like to remind you of the decision given at the Hague Tribunal over the long drawn-out controversy over the imposition of house-tax on foreign residences within some sections in Kobe, Yokohama and other treaty ports, where extraterritoriality was granted long ago. The Japanese Government and people declared that foreigners had become liable to taxation because extraterritoriality was abolished, while foreign residents declined to fulfil their obligations on the pretex that they still held perpetual lease in the specialize zone. The Japanese thought their claim was reasonable and justifiable. And the matter was brought to the Court of Arbitration at the Hague.

The Court finally came forward with a verdict which rejected Japanese claims contrary to our expectation and despite our great efforts made in defence of our position. This decision naturally gave an impression that the idea of justice of the Japanese or of the Oriental people would never be respected in the face of material expediencies of Europeans and Americans. It is simply for this reason that our people have since come to distrust the fairness of the Court of Arbitration or the International Court of Justice. The sentiment is also noticeable in the Privy Council.

We have recently suffered from another instance of the same character but of greater consequence. That was the decision of the Legaue of Nations which, with a vote of 42 against 1 of Japan, rejected the recognition of the Japanese stand in the Manchurian situation, which rejection has been considered as an act of absolute justice by the whole nation since the outbreak of the incident. Unfortunately there was not a single country which took cognizance of Japanese principles of justice. This made an addition to the sentiment that our justice would never be approved of in cases when it runs counter to the interest of the Westerners.

We cannot disregard this sentiment in discussing our position in international diplomacy in the future, more especially in regard to the forthcoming naval disarmament conference which is destined to be held in sequel to the London Conference. The sentiment naturally makes us entertain an apprehension of the possible inclusion in the agenda of the Manchurian problems and other Oriental issues, which may put our position in such a sorry plight as was experienced at the last League meeting. As a matter of fact, a section of opinion holds it that in the coming conference various political problems affecting the situation in the Pacific and China should first be discussed as a *sine qua non* for naval allotment.

If this sort of opinion finds its application at the coming conference, the rôle which China and the Soviet Union will play in the conference will necessarily make the Pacific problems once more major issues, and divergence of views may oblige Japan to quit the conference. This is an apprehension which is common in the minds of the Japanese as a whole. And this gives rise to a sense of emergency and of some diplomatic crisis in 1935. It behooves the government authorities to take due account of this apprehension and to preclude Far Eastern problems being discussed in any international conference in the future.

Manchoukuo is a Sort of Compromise

A Chinese gentleman who has recently visited Tokyo put forth his objection to our recent move and said that the Japanese occupied Manchuria, proclaimed a hereditary monarchy to rule over the country and seemed to be looking for a chance to sweep over North China with their military forces. Then he pleaded that the Japanese should not harbor aggressive designs on China Proper, and that Japan should give a solution in some form or other to the Manchurian problems in order not to spoil Chinese prestige and to open up a new avenue of friendship between the two countries.

An analysis of the sentiment of both nations will reveal that there has been a wide divergence of views between the two peoples since the outbreak of the Manchurian incident. The Chinese have been apt to think that the Japanese with their strength with which they swept over Manchuria were turning their attention to China with a view to make it a protectorate and restore the Ching dynasty there. This suspicion is rife now-a-days among the Chinese, consequently a section of the people resorts to the folly of an attempt to check Japanese influence by the aid of a third party whether it be the League, the Soviet Union or any other country.

But the Japanese view differs largely from that of the Chinese. According to the view common to the Japanese, Manchuria is the region where their supremacy was established by great efforts and material sacrifice through the two wars there in the past, and therefore it is the place which is left for their activity, particularly at this time when their compatriots and their trade commodities are being driven out of various parts of the world. But the Chinese attempted to suppress our activity even in this special region. The consequence was the outbreak of the Manchurian incident and the independence of Manchoukuo.

The independence is flagrant proof of Japanese indifference to territorial ambitions. Manchoukuo is an independent state established by the Chinese race, and will never be annexed by Japan. I may therefore conclude that the independence is a compromise solution of the problem between the two nations, which manages at the same time to save the prestige of China and to satisfy the desire of Japan. The Japanese felt a sense of relief over this compromise solution, and will no longer seek any aggression whatsoever into China.

If Chinese take into full account the state of the Japanese mind and position, I am perfectly confident that they will have to admit that the recognition of the existing status in Manchuria is itself a permanent solution of the Manchurian problems. The late Dr. Sun, founder of the Kuomintang party, once committed himself to conceding that Japanese desires would be carried out in Manchuria. Mr. Eugene Chen also pledged himself to the same effect to me in Shanghai several years ago when the Canton Government was established.

One of the recent changes in the attitude of the Japanese towards other nations, to which I should like to invite special attention, is the fact that we cannot longer tolerate the Chinese traditional diplomatic tactics—that is to pit one barbarian against other or in other words to win over a third party to take the part of China, for the purpose of impeding legitimate activity of Japan in China. Japan desires neighborly relations with China. She is concerned seriously about the maintenance of peace and order in the Orient in view of her special mission in this part of the globe. And peace and order may only be achieved by co-operation between the nations in the Orient but can never be done by the interference of other countries. We have no aggressive purpose regarding China, and what we seek is the integrity of China and her good order and prosperity. In order to attain this end, there will be nothing more constructive than an awakening on the part of the Chinese, and there will be no greater folly than a reliance upon a third party to antagonize Japan.

"Collective System" not Acceptable

A British newspaper man of considerable social prominence contended in an interview with me that the conference between nations has become an established form of deciding world affairs, just as the integrity of China was discussed at the Washington Conference and the League of Nations. He referred to the words of Mr. E. R. Cecil to the effect that the "collective system" should be maintained at all hazards, and then to Article 7 of the Nine Power Treaty which provides for the exchange of views between countries.

Japan has attained her present state of development in industry, trade and in all other branches of activities on account of her toil and moil through sixty years in the past. But now she has found herself in an awkward position in which her emigration is barred and her export trade restricted. She was at one time on the verge of being wiped out of Manchuria which was thought to be the last field of activity for her population and industry.

A collective system as advocated in Britain may be an important instrument for some European and American countries which are eager to hold on to the *status quo* for the spheres of influence they have established throughout the world. But Japan is in need of a more acute and necessary doctrine for herself. The 7th article of the Nine Power Treaty provides for an exchange of opinions between signatories in the event of there being conflict of opinions as regards the application of the provisions in the treaty. Japan in always willing to abide by the spirit of this article as she has done in the past. But she is not in a position to accept the invitation to a conference which is likely to oblige her to leave in indignation. The Nine Power Treaty does in no way interfere with the inherent position of Japan in the Orient.

A British Viewpoint About Japan

Parliamentarian Presents Review of Recent Events and Justifies Acts of Nippon

By W. KIRKPATRICK, M.P., in "English Review"

EVER since I have been in the House of Commons after almost every question asked in regard to China and Japan, I have refrained from asking a very obvious supplementary question. I have refrained because I felt it would be a reflection on the knowledge of the House. The question I have had in mind was this: "Is it not a fact, and is the fact fully and properly realized, that Japan is a united national entity—and that China is not?" I cannot believe that the Opposition and a few other members of the House who show a palpably anti-Japan bias are not fully alive to the conditions which have existed in China for the last 20 years.

"The truth is that while China is divided up into a variety of different races and languages, and is not even nominally a federation of states, Japan is a unified, well organized, united kingdom. I have, indeed, heard Japanese friends express pride and pleasure that, Japan is comparable with England. The geographical position of the islands comprising Japan—their relation to the contiguous continent of Asia, is remarkably similar to that of England, Scotland and Ireland—in juxtaposition to the continent of Europe.

"This analogy can be carried still further. Japan has many problems similar to ours. Her people are a maritime, sea-faring people. They face and overcome adversity. Japan has, moreover, a much smaller capacity for producing food even than we have. Besides Taiwan, she has no colonies. The greater part of all her islands is uncultivable. Japan, like ourselves, has to rely on industrial development to enable her to produce goods to sell in return for raw materials, and—in increasing quantities—for foodstuffs. Japan has a rapidly increasing population—a virile, adventurous, persistent people. Within seven decades they have adapted themselves to every influence of modern civilization. They have adopted, adapted, and perfected modern material processes in every phase and aspect. The foundation on which they have built their present up to date structure is the ancient civilization of China. Their written language or ideography is Chinese—their artistic sense and tastes have been influenced by, and, indeed, originated from China.

"Their army has been created and organized on European lines; education has been based on German principles; railways on American; their navy on our navy. Many of their leaders in all walks of life are Christians.

Two Years in Japan

"I spent two of the most interesting and pleasant years of my life in Japan. Breaking away from the conventions and the now dying "extraterritorial" atmosphere of Yokohama and Kobe, I lived in the heart of Tokyo.

"On my return to London in 1926, I had the privilege of a long talk with the late Lord Birkenhead—then Secretary of State for India, about Japan and Manchuria. What I said then in effect was this: I said then and I am more than ever convinced now, that the only possible chance of peace coming to Manchuria is with Japanese guidance, surveilance, and temporary suzerainty. At that time it was common knowledge that for many years previously a movement had been on foot to restore the Manchu dynasty, if not to the throne of China, to their own original kingdom.

"I met a Mr. Ku Hung-ming in Kyoto in 1924. He must then have been 65. He was touring Japan lecturing in faultless English to Japanese audiences, 'promoting cultural relations between China and Japan,' with a strong bias against the new Chinese Republic and the 'New Learning.' He claimed that his loyalty to the Ta Ching Dynasty was a loyalty to the religion of China, the Great Code of Honor and Duty: Ming-fen-ta-yi, the Religion of Loyalty, the Law of the Gentleman.

"'In China,' he said to me, 'Demo-crazy (sic), which has come with the New Learning, has destroyed the gentleman, and therefore in China now we have no government.' Ku Hung-ming had been secretary to Viceroy Chan Chih-tung in Wuchang—and it was generally accepted in Japan that he represented loyalist ambitions in Peking and Manchuria. I heard recently that he died in extreme poverty a year or two ago in Tokyo.

Manchuria's Sovereignty

"And here I join issue with the League's finding that 'the sovereignty over Manchuria belongs to China.' Before the dissolution of the Chinese Empire—antecedent to the temporary abrogation by Yuan Shih-kai, the association of Manchuria with China was dynastic; comparable to the Union of England with Scotland in the 17th century. The 'King' of Manchuria became (but by conquest) Emperor of China—as the King of Scotland became King of England. On the fall of the Manchu dynasty in Peking, Manchuria came under the sway of Chang Tso-lin and his son and successor Chang Hsueh-liang, neither of whom acknowledged the suzerainty of any Chinese authority.

"The Lytton Report explains that Chang the younger 'seems to have looked upon his relations with the (Chinese) government.... in the sense of a personal alliance.' Even after this working arrangement made in 1928 with the then Nanking government, 'the old system....continued to function as before.' An arrangement, let it be admitted, which suited Japan and which she more than tolerated in view of her knowledge, shared by every intelligent neutral foreign observer in the Far East, of the events which were to follow.

"During my visit, Manchuria was governed by Chang Tso-lin, with Japan closely watching his steps. He may have been on leading strings. He was kept in power in order to secure, as far as he was able or could be persuaded to, the maintenance of and some respect for Japan's treaty rights in Manchuria. The nebulous governments of Peking, Nanking, and Canton were incapable of respecting anybody's—far less any international obligations and treaties. Put it this way—Japan kept an eye on Chang Tso-lin and made use of him until someone of greater authority and authenticity was ready to take his place.

"I have reason to believe that ever since the expulsion of the successor of the dethroned Emperor from Peking all the best elements, including the best Chinese in China and in Manchuria, were hoping for and working for the release of Manchoukuo from the control of adventurers and for its restoration to the Manchu dynasty.

"That restoration has now been effected with Japanese assistance and recognition. Even under the régime of the Changs in Manchuria, Japanese surveillance ensured a measure of law and order, not to say some prosperity, and peace at least far greater than prevailed—or prevails to-day—in any other part or province of China.

"The 'personal alliance' with the variegated 'government' of Nanking, probably because it had acquired a 'face saving,' stimulus through the recognition by the powers of its claim to an 'all-China' status, encouraged the younger Chang to further despotism and to the oppression which had characterized the rule of his father the old Marshal Chang Tso-lin. Japan's surveillance became increasingly delicate and difficult, though a movement was now rapidly developing in Manchuria in opposition to Chang's policy of military adventure in China.

"The Manchus, let it be recognized, are a very real people and are as distinct from the peoples in the Yangtze valley and Canton as are the peoples of south and northern India. A deliberate and definite self-determined desire manifested itself in Manchuria for peace at home. This movement was initiated by leaders of the people in Manchuria itself and was encouraged by many prominent and exceptionally capable men in China, who retained an intense traditional loyalty to the Manchu dynasty, and hoped and worked for its restoration for the previous 20 years.

" When the younger Chang, with his ' personal army,' retired beyond the Great Wall the movement gained momentum. Chang's entourage of hirelings were replaced by local leaders of authority, and district, provincial and literally national committees and councils were organized to maintain order and to carry on forms of localized self-government which the people of the country have been used to for centuries. The anti-Chang feeling found freedom of expression and obviously with Japanese encouragement and approval, the independence of Manchoukuo under the descendant of the last Emperor was proclaimed.

Japanese Reluctance

" Here, again, when it is a matter of knowledge, it is impossible not to appreciate Japanese reluctance to accept the League's dictum that the movement of Manchurian self-determination was ' conceived, organized, and carried through' by ' a group of Japanese military and civil officials.' Our history in India and in other parts of the world afford parallel instance after instance of good work by our political officers and diplomats where we have been involved in restoring dynasties small and great and in giving friendly guidance through our men on the spot to secure the restoration of a monarch who would suit the people and our own interests best. Is the gravamen of the charge against Japan then, that her intelligence service and her local diplomacy has been too efficient ? What about the Punjab, or Oudh or Hyderabad and the Nawabs of Bengal, not to mention Egypt in more recent history ?

" Japan is no less and no more justified in her approval of the displacing of adventurers who had no title to rule—who ruled by the force of mercenaries and by extortion—than we were before and after all India came under tne Crown, in approving and assisting the setting up of rulers in disorganized states in India.

" And history proves that we were justified. The Lytton Committee, moreover, would not appear to approve of the restoration of the Chang régime : an argument the logic of which Japanese opinion cannot understand. Supposing, they say, the people of Manchuria favored Chang's return, why deny it ? But if the will of the people is against any such return, how can it be argued that the present position is only due to Japanese coercion and Japanese machinations ?

" Japanese opinion is unanimous in contradicting the charge that the recognition of the new State of Manchoukuo constitutes a violation of the Nine Power Treaty. The Japanese contend, in the words of Count Uchida, ' that the Nine Power Treaty does not forbid all separatist movements in China, or debar the Chinese in any part of the country from setting up of their own free will an independent state.' It should be recorded that Count Uchida, who was Foreign Minister, has repeatedly stated, as have done representative Japanese statesmen on every possible opportunity, that Japan disclaims ' any territorial designs in Manchuria or anywhere else.'

League's Action

" The League, with lugubrious solemnity, has ' found' Japan to have acted contrary to Articles 10 and 12 of the Covenant. The violation of Article 12 requires, theoretically at least, the application of the economic sanctions provided for by Article 16. But is this practicable at the present, or any time ? Article 16 in its present form has long been recognized as being unworkable. On the top of what Japanese opinion is not alone in considering the unrealities, a new committee has been set up. And—more unrealities—this committee has solemnly invited the collaboration of the United States of America and the United States of Soviet Russia to go *inter alia*, presumably, into the question of an embargo on armaments.

" Meanwhile, Jehol has been restored to its proper place within the comity of Manchoukuo ; Japan needs no arms ; the United States of America can be presumed to have concluded the supply of any arms China is ever likely to require for the reconquest of Manchoukuo ; and the United States of Soviet Russia, not being members of the League, continue to occupy as much of western Manchuria as they desire, without leave or hindrance from the League of Nations or anyone else.

" Let me make a confession ; before I left India I was intolerant of Japan and the Japanese, being influenced by the fact that I saw then the beginnings of intensive competition from Japan in all our world's markets. I saw Japanese firms in Calcutta competing with British firms, not only in imports of cotton textiles and other goods into India, but also in exports of the principal commodities, such as jute cloth, from India. Japanese ships were competing in exchange ; Japan had the match monopoly ; Japanese buyers of cotton were establishing themselves in the principal cotton-growing districts all over India.

Mistaken Belief

" I had heard before I went to Japan that while a ' Chinaman's word was as good as his bond, a Japanese was commercially untrustworthy.' My two years in Japan proved to me how utterly and entirely mistaken I was in my prejudgment. I formed friendships with Japanese of every class from the highest in the land to the lowest. I found them neither subtle nor inscrutable. And I found that man for man, and every time, it was the people of this country they admired most, got on best with, and whose comradeship and guidance they desired.

" As a businessman—representing the leading British firm in Japan, which had been established there for 50 years and whose name was a household word—I had special facilities, for contacts and friendships not ordinarily accessible to our Embassy, or consular services. With my long Indian experience as background and as stimulus, I was a keen observer. Japan is being misunderstood. To me, her motives are as simple and as clear as have been her asseverations at Geneva. She has a duty to herself, to her own 2,000,000 nationals in Manchuria and especially to the 20,000,000 of Chinese refugees who have sought sanctuary in Manchoukuo from the chaos, communism, and banditry which has shocked, shaken and ruined every other province of what was once the Chinese Empire.

" China is bound to fulfil treaty rights and obligations entered into with Japan—entered into with the approval and knowledge of the whole world. Treaties and agreements which involve not only Japan's investments of over £200,000,000 in Manchoukuo, but also individual responsibilities which she was encouraged by all the great powers to incur in the interests, I assert, if not of the whole world, at least of every part and province of China. No power or people in the world has a more intimate knowledge of, or keener sympathy with the aspirations of the people of China than have the people of Japan.

" Every good quality of the people of China is understood and fully appreciated by all classes of Japanese. Chinese and Japanese businessmen, intellectuals, and statesmen have the highest regard for each other. Many of the latter-day generals in China were educated and trained in Japanese military academies. Japan is always a safe refuge for Chinese leaders and politicians who need a home. It is true to-day that some of the best elements in China—certainly in Manchuria—are in association with Japan in the endeavor to establish, as they certainly will and as recent events show they are on the way to do, at least one peaceful, prosperous province, an example which will surely be followed by other provinces in China. Japan is showing the way.

" And here is a very significant fact. Ten, even five years ago, it would have been true to say that most British, perhaps most Europeans living in China, were anti-Japanese. Some nations, influenced, I am bound to say, by certain foreign missionaries, were strongly prejudiced against Japanese influence and Japanese trading activities in China. And to-day nearly every British publicist, journalist, or businessman in China has swung almost completely round and on the Manchurian question sympathizes more with Tokyo than with Nanking.

" This sympathy is prompted primarily by concern for and appreciation of the people of China ; and for this reason most Englishmen with a real knowledge of Sino-Japanese affairs state that it will be for the good of those unrepresented millions of Chinese that Manchoukuo has been established as an independent self-governing state. This purpose can only be attained with the direct aid of Japan, and by exactly such direct action as Japan has been taking.

Stabilization of Yangtze

" The next step I prophesy will be the stabilization of the Yangtze valley with Shanghai as its apex and as entrepot for an area embracing a population of some 150,000,000. This will come automatically and unaided by any outside influence and/or control. Japan fully realizes this development, and has no reason nor would

she have any justification for interference in spheres beyond which she has clearly declared are the limits of the objective and policy. I for one believe that she will abide by her undertakings—unless by our unfriendliness we goad her into further isolation.

"While obviously Japan has had and will continue to be accorded, most-favored nation treatment from Manchoukuo, a settled Manchoukuo—with the favorable repercussions on contiguous provinces—would open out opportunities for British goods and British trade which we have been waiting for for the past 20 years. The development of Japan meant orders for British-made machinery, plant and goods of every possible description. China, with its 400,000,000 at present import two per cent of the world's trade—its potentiality as a buyer of world's goods has been described as a vacuum. No country can expect to have the monopoly of supplying all the goods China or any province or part of China requires to import.

"The establishment of Manchoukuo is, I believe, a beginning in that final settlement of peace and opportunity for unfettered action and trade which not only we desire—even if our motives are not entirely disinterested but which all the people of China if capable of giving any expression themselves desire more than anyone.

"Japan has always sought and appreciated and valued our comradeship beyond compare. She does so to-day more ardently, and in my view, deserves it more than ever before. I appeal for understanding and sympathy for Japan in the difficulties of the position she has been forced into, almost literally with her back to the wall.

"Whether from a sentimental or from a purely material point of view, I consider it more valuable to maintain this potential friendship with Japan—and with India and China—than with any other country in the world, our own colonies and dominions excepted. From these three countries we will receive, whether it be trade or friendship, more than we give.

"I look back to 1921. As the world knows, or believes, we were cajoled then into abrogating a treaty which Japan had honored so steadfastly and so loyally. We were suspected, but forgiven for having abrogated, to placate, as a Japanese friend described it, a 'nation whose head was swollen with gold.' I beg we see to it that we are not diverted again.

"As a Lancashire member, I would point out that we in Lancashire have suffered from the intensive competition of Japan not only in our colonies, but all over the world. To meet and overcome this competition there are certain commercial treaties with Japan which we must at an early date terminate. The necessary and delicate negotiations to this end can only successfully be entered upon and concluded—if we are to obtain full reciprocal benefits—in an amicable atmosphere.

"I say it with a full sense of responsibility and in all earnestness, it is my very deep conviction that in regard to Manchoukuo, Japan is right. The Lytton Report, with all its transparently sincere intentions, with all its obvious straining to be sympathetic (and consequent failure to be fair) to both sides, is wrong. Thus the Geneva decisions are wrong and are and always will be unacceptable to Japan."

Japan's Back to the Wall

By ARTHUR BRISBANE, Editorial Writer of the Hearst Newspapers in the United States

(The following article appeared in the Hearst newspapers in America on May 6 this year).

MORE than one of the great nations worry about Japan. Britain, especially, with her gigantic interests in Asia and huge trade with China, is disturbed by Japan's new "Monroe Doctrine" for Asia.

Japan's Asiatic population is 70,000,000, against Britain's subject populations of 300,000,000 Hindus and Mohammedans in India, yet Japan, ignoring the British Empire in Asia, says, in fact:

"I shall say what is to be done about Asia and Asiatic nations. Other countries dealing with Asia, China especially, must deal with my consent and according to rules laid down by me."

Some, foolishly, predict war between this country and Japan, a war that could never happen except as the result of stupid brutality and ignorance on one side or the other. Others predict a second Japanese-Russian war, with better reason.

Japan, in Manchoukuo, has established herself on the eastern border of Russia, which is as though she had moved in full power just across our Mexican or Canadian frontier.

With that situation Japan and Russia must deal, and it is to be hoped the negotiations will not end in war, the last resort of international murderers.

It is important for citizens of this country to examine, understandingly and sympathetically, to-day's conditions in the Japanese Empire, making allowance for the pressure, at home and abroad, on a government facing desperate problems.

Japan, an overcrowded nation, faces the alternative of starvation or expansion. Thirty years ago Japan's population was 30,000,000, now it is 70,000,000. Imagine the population of Texas suddenly increased to 70,000,000, and you would imagine a condition very simple compared with that of Japan.

Every acre of Texas, under modern methods of cultivation, fertilization and irrigation, could be made highly productive. It has been shown that the soil of Texas alone could supply with food the entire population of the earth, about 1,800,000,000.

In Japan only about one acre in five is fertile, available for profitable cultivation. The population of Japan equals 433 to the square mile, and, most dangerous feature of the whole situation, that population is increasing at the rate of 750,000 a year.

Emigrate Where?

It is suggested that the Japanese emigrate, but whither can they go?

The great empire of Australia, to the south, with a thin scattering of population, is closed against them by the will of the Australians and the power of the British Empire. They are forbidden to enter an island continent where not one acre in 100 has ever actually been seen by the eye of a white man. Across the Pacific this country, Mexico, and Canada, the great stretches of Alaska, are closed against Japanese emigration.

The Japanese, mistakenly but naturally, look upon this exclusion by the white race as an insult to Japanese nationality.

It is, on the contrary, an acknowledgment of Japan's high qualities of efficiency, industry, perseverance. We have seen, in California and elsewhere, that the white man cannot compete on even terms with the Japanese. He will not work as hard or as long, will not be satisfied with as little. And it has been shown, in the opinion of the white race at least, that a satisfactory mixing of the races is not possible.

Hard Job for Japan

Japan, her population increased by 40,000,000,—more than 100 per cent—in 30 years, with a yearly increase of 750,000, encourages emigration. But in all the years of Japan's modern era emigration from Japan proper has amounted to fewer than 3,000,000. Birth control has been urged, but national tradition and biology control that.

Everything the Japanese can do they have done with the territory where for so many ages they lived secluded and at peace with the rest of the world.

When Marco Polo, ancient Venetian traveler, brought back from the court of the Mongol Emperor Kublai Khan, in China, news

(Continued on page 332)

Water Supply in Hongkong

The Story of a Triumph of Applied Science

By Professor C. A. MIDDLETON SMITH, M.Sc., M.I.Mech.E. (Dean of the Faculty of Engineering in the University of Hongkong)

PART I.—THE MANY DIFFICULTIES AND FIRST EFFORTS

THE story of the water supply to Hongkong is one that should be of great interest to everyone who lives in China, whatever may be his trade or profession.

It tells of unexpected and unforeseen difficulties overcome; of the triumph of human knowledge over the vagaries of the weather, and the problems that arise out of the sudden growth of great modern cities. That growth was a distinguishing feature of the last century in Europe and North America. It is taking place in Asia during this century. And in the old, as well as in the new cities of Asia, there is a growing demand for the amenities of life, provided by applied science. A reliable supply of pure water takes a front place on the list of these demands.

China is being suddenly catapulted, as were, into an intense industrial age. An inevitable result must be the creation of large urban communities. The almost sudden development of Hongkong and Shanghai, and the recent transformation of Canton, provide evidence of this inevitable change due to the spread of a knowledge of applied science. The experience gained in other parts of the world should be invaluable in the planning of these new cities. The mistakes made in other places, so expensive to rectify, should be avoided in China.

Government Control

The growth and development of large urban communities makes a pure water supply imperative. The subject is therefore of immense importance not only in China, but all over Asia, where many changes due to applied science are so rapidly taking place.

The increasing number of young Chinese who study scientific subjects abroad and in their own country, and the improved facilities for travel and communication, have produced a demand for reform in all sorts of directions. As engineers we are not immediately concerned with politics, although we cannot be unobservant of the trend of modern thought which favors government control of public health and certain engineering works, such as water supply, which are carried out for the benefit of the community. The many and various engineering schemes published by the Central and Provincial Governments of China give proof of the tendency to favor Government Control. It cannot be doubted that, in China as elsewhere, conditions make such a design of a carefully planned and comprehensive scheme for the supply of water over a large area preferable to a number of independent and un-co-ordinated arrangements, if it is possible to arrange the financial and technical details of the system in a satisfactory manner.

Every town or city has its own peculiar local conditions which affect the problems connected with water supply. Thus, if we consider the City of Glasgow, in Scotland, we see that not far away is a large lake with almost inexhaustible storage capacity, surrounded by hills unsuitable for dwellings or agricultural land. The lake is sufficiently high above sea level to allow the water to fall by gravity to Glasgow, and so there is no cost for fuel, etc., for pumping. The supply to the citizens of Glasgow is practically unlimited, and in practice the consumption of water averages about 100 gallons per day per head of population.

The Increasing Demand

In other places the consumption is much less—fifty years ago it was less than six gallons per day per head in Hongkong. Today it is about 20 gallons, but if the people in the slums had baths fitted in their dwellings and if the flush system of sanitation were universal, a fair allowance would be about 40 gallons per day per inhabitant.

Everything points to the fact that the demand for water will increase in Hongkong. In order to understand the difficulties overcome, and those that still face those responsible for the water supply, a general outline of local conditions is now given.

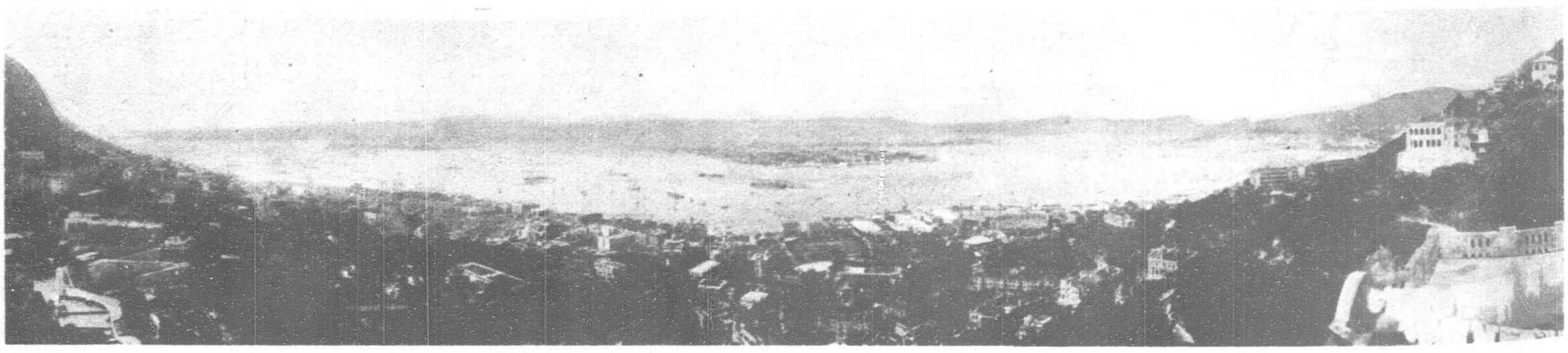
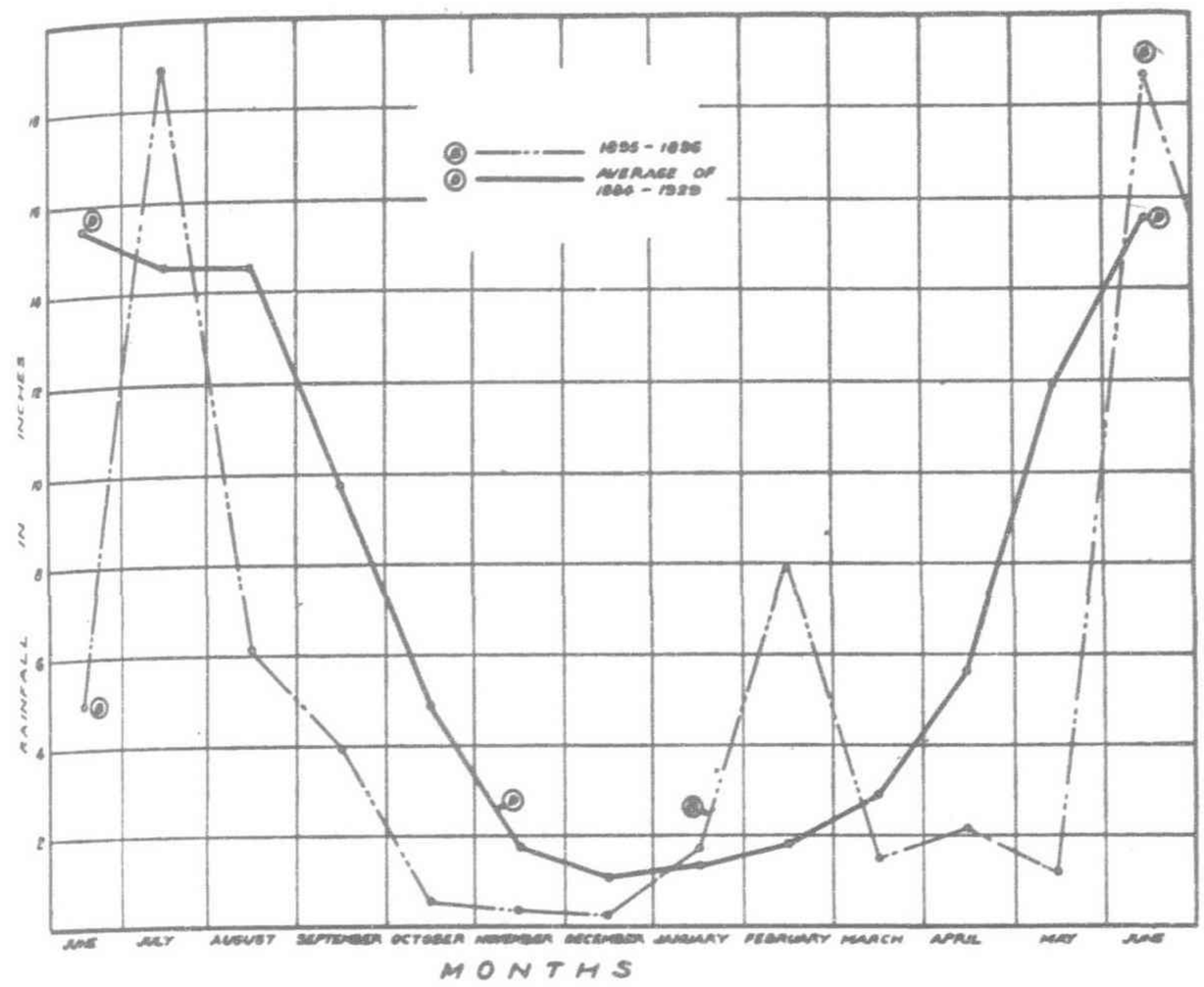
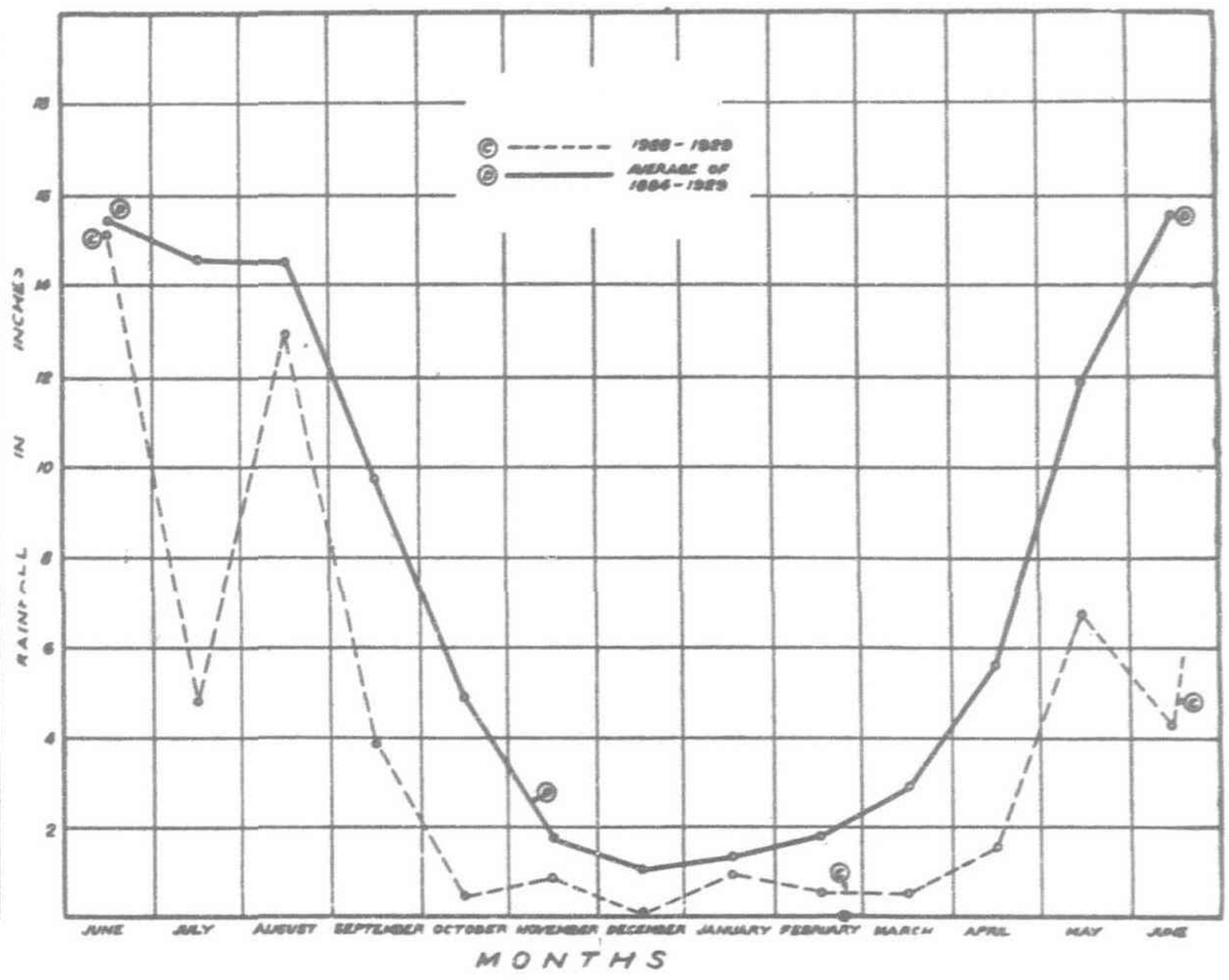


Fig. 1.—View of Hongkong Harbor from the Peak on the Island overlooking Kowloon

Fig. 2.—View of Hongkong Island from Hongkong Harbor





Figs. 3 and 4—Curves showing Variation in Hongkong Rainfall

Hongkong is now one of the most important shipping centers in the World. The magnificent harbor (Fig. 1) provides a safe anchorage for an almost indefinite tonnage. On the island (Fig. 2) the city of Victoria has grown, and more recently Kowloon (Fig. 1) has been built; water must be supplied to these two cities and to the ships.

In relating the details of the growth of the efficient water supply in Hongkong, and the plans for improving it in the near future, an attempt will be made to tell the story in such a manner as will be of practical service to those interested in similar problems in other parts of the Far East. The language used will be simple, and non-technical, in the hope that those who know little or nothing of applied science will interest themselves in a subject vital to the solution of the great task before us viz., that of raising the standard of living amongst, not only the millions in China, but also those other millions in other parts of Asia who have not yet utilized the vast sources of energy provided by Nature to improve health and to relieve mankind of monotonous manual toil and stultifying poverty.

The Inevitable Transformation

When we consider the amazing transformation in the daily life of people in other parts of the world that has been brought about in a few years by the application of scientific knowledge to the problems of existence, we can be sanguine of the success in the near future of those who are striving to raise the standard of living in China.

Mechanization, in Japan, has caused a big rise in the standard of living. It has been stated that wages have increased four times as much as thirty years ago in that country. We may be certain of that ultimate success in China, although we realize that the factor of time is dependent upon the growth of public opinion in favor of applied science. We must not allow ourselves to be discouraged in the crusade for the creation of new engineering schemes, and the extension of those already accomplished in China, because of the conflicting political and industrial interests that often retard development.

Rather should we be encouraged by the evidence of progress made by engineers in China during the last ten years, in spite of the chaos and turmoil caused not only by those conflicting interests, but also by and the terrible disasters resulting from the neglect of scientific control of the rivers that have flooded huge areas of the country. Beyond all else should we be encouraged by the great change in outlook towards science in all sections of Chinese communities. Whereas only a few years ago there was a sort of superstitious opposition to any new ideas, there is now in many quarters an eagerness to adopt the aids offered by scientists to improve the conditions of life by utilizing the resources of nature available in China.

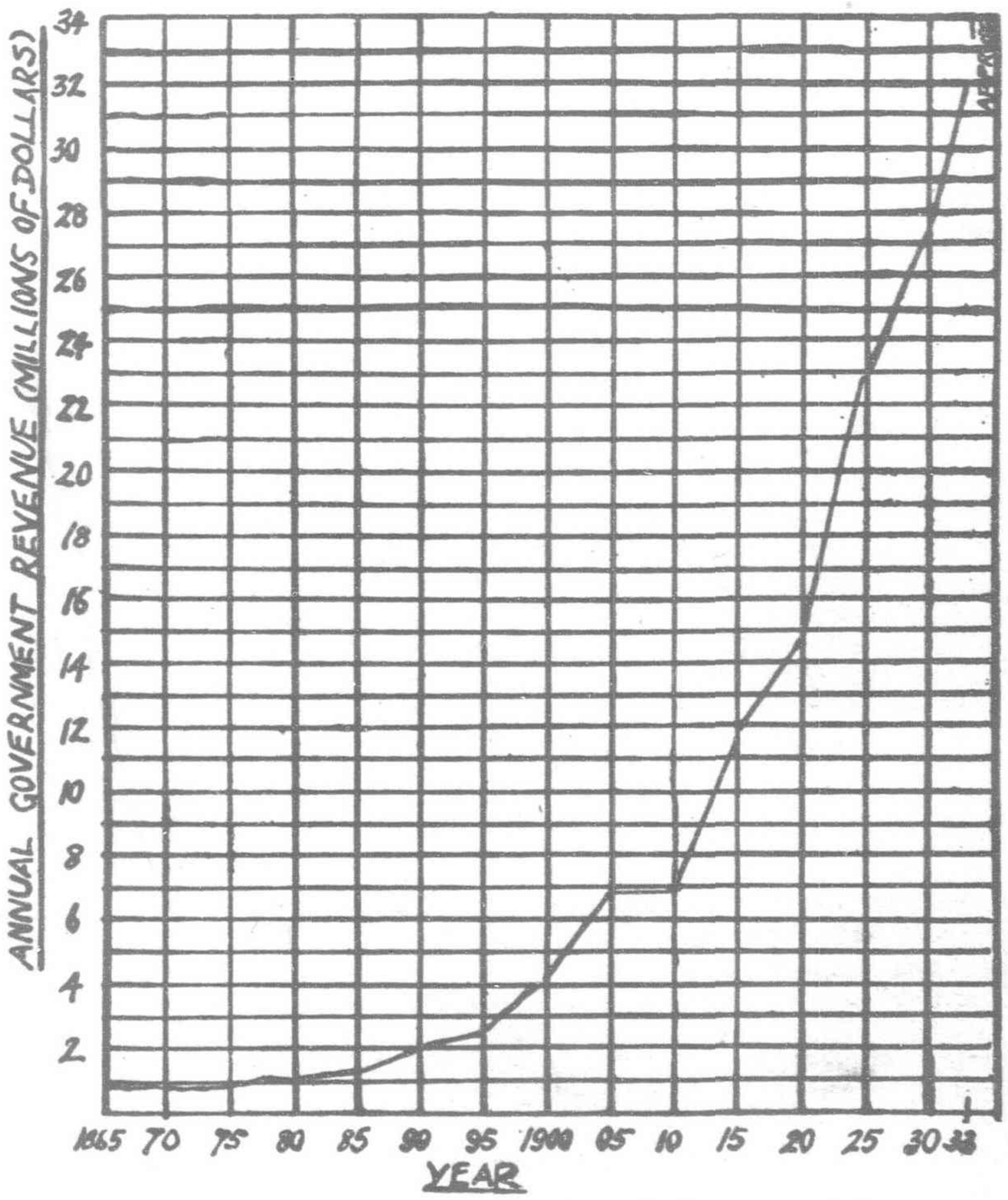


Fig. 5.—Curve to show Increase in Annual Government Revenue of Hongkong, 1865—1933

The Three Schemes in Hongkong

Since the supply of pure water is a fundamental necessity for the good health and efficiency of any urban community, the experience gained, and the problems successfully solved, in Hongkong provide valuable data and a guide to those who wish to improve the conditions of daily life in the Far East. Let us therefore consider the matter carefully, duly noting all of the many details connected with it, and eager to use the information for the purpose of persuading those in authority to adopt similar measures in other places.

The water supply of Hongkong may be divided into three sections viz (1) the supply for the island of Hongkong (2) the supply for Kowloon, including the preliminary work in the Shing Mun Valley (3) the huge new works now being carried out in the Shing Mun Valley (in the New Territories), where a reservoir is being built which, when completed in four years'

time, will be so big that it will more than double the existing storage capacity, not only for the island of Hongkong, but also for Kowloon.

It is hoped to deal with each of these sections in detail ; as that is impossible in the course of one contribution, this first article will be devoted to general considerations connected with water supply and a description of the arrangements that have been made to ensure a satisfactory system for Hongkong. Details of the other various works in Hongkong will follow in future issues of this journal.

In order that the reader may appreciate the rapidity of the development of the water supply under discussion, the following dates are given. In 1863 the first attempt was made to arrange for a public supply for the city of Victoria, on the island of Hongkong. In 1883 the Tytam Valley scheme of reservoirs, catchments, etc., was begun on Hongkong island. In 1910 there was built the first reservoir for a public supply in Kowloon, the new city on the mainland opposite Victoria. In 1917 the Tytam Valley scheme was completed by the opening of the last of the reservoirs (Tytam Tuk) built in that valley. In 1924 the first work on the remarkable Shing Mun Valley scheme was commenced. In 1932 work began on the big modern dam of unique design at Shing Mun. The new reservoir out there will be completed, it is believed, in 1938.

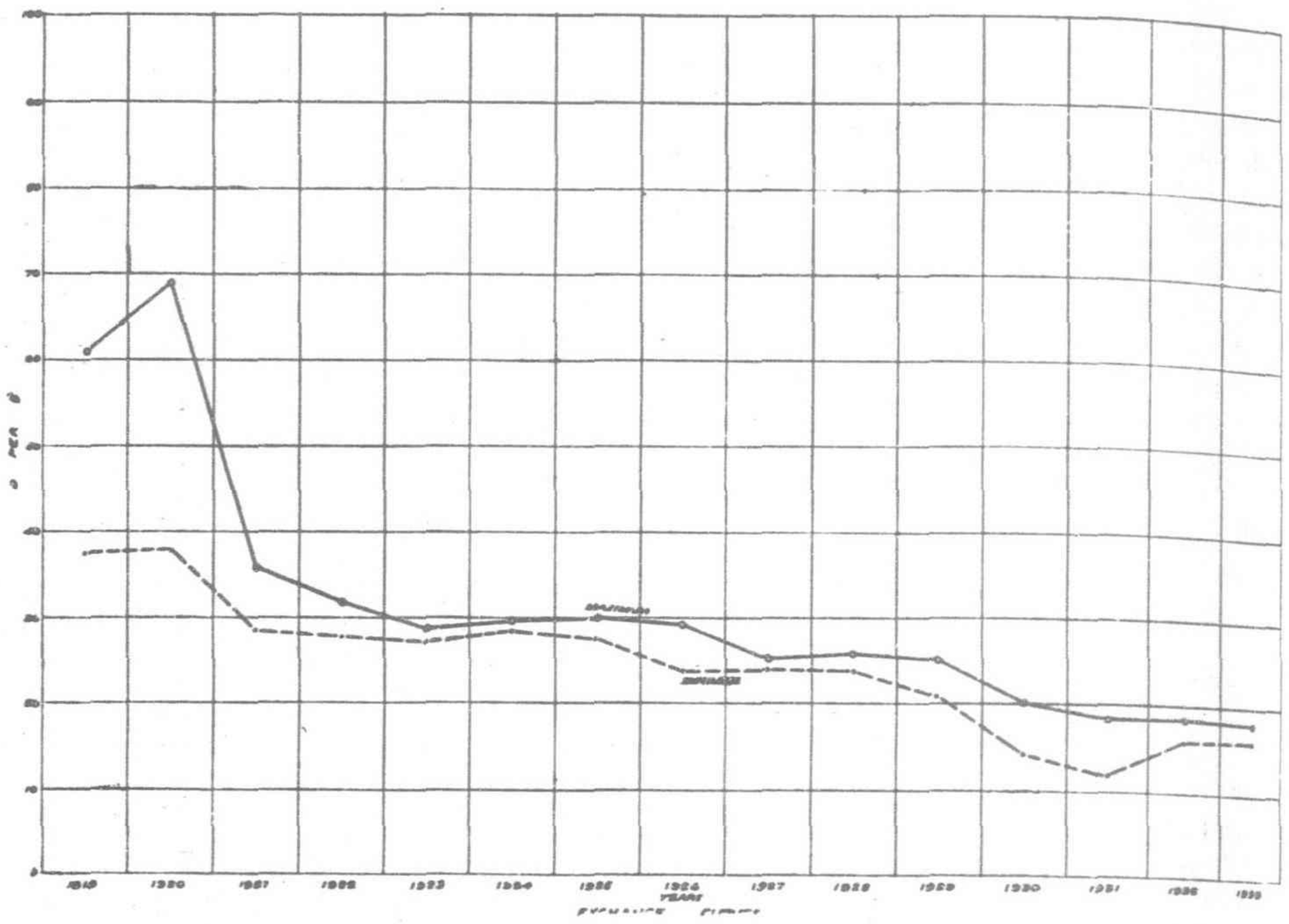


Fig. 6.—Variation in the Hongkong Dollar and Sterling, 1919—1933

An Increasing Demand

New information concerning the remarkable work now being carried out in the Shing Mun Valley (a preliminary statement of which was published in the *Far Eastern Review* in June 1933), will be of particular interest, as the technical difficulties envisaged and overcome were very unusual, as is the final design of the dam.

At this time of writing (1934) the average daily consumption for Hongkong island is about 11 million gallons and in Kowloon it is about seven millions, a total of about 18 million gallons. Clearly it is no easy problem to meet that great demand for pure water throughout the year.

It is of interest to note that in October, 1933, the total storage capacity of all the eleven reservoirs in the Colony was 2,983 million gallons and that the new reservoir now being formed at Shing Mun will hold 3,200 million gallons.

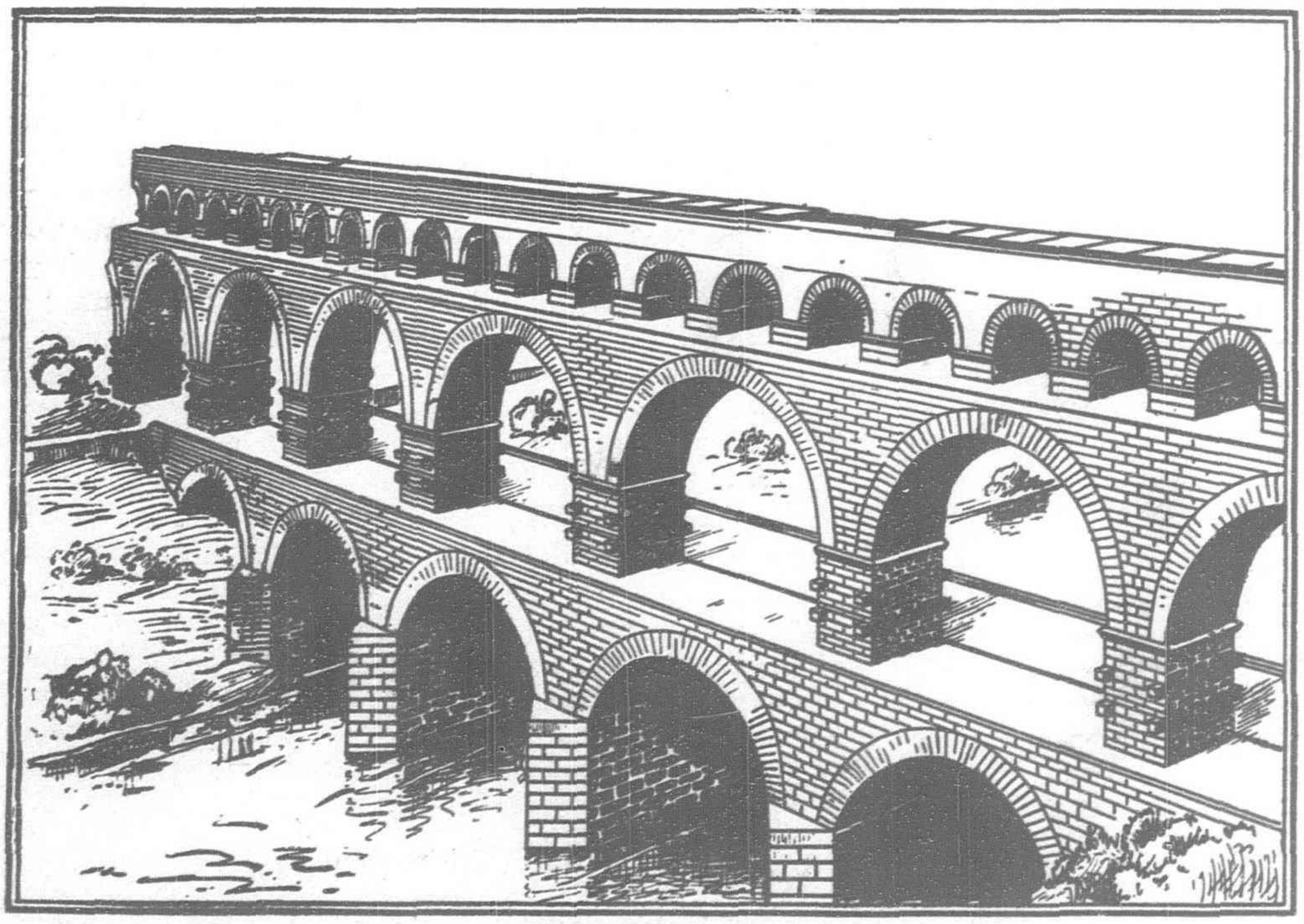


Fig. 7.—A Roman Aqueduct. It is an interesting fact that the Romans arranged for the flow of water along great distances at a level just sufficient to give a low velocity in a conduit never above atmospheric pressure

The Many Difficulties

It should be understood that the problems of water supply include those concerned with the provision of large areas free from pollution for the catchment of rain water ; the construction of channels or catchwaters to divert additional water to reservoirs ; the building of the dams, etc., for the reservoirs the filtration, and provision or service reservoirs for storage of filtered water ; the distribution and metering of the water, and the complicated arrangements of finance and administration.

In any scheme we must take into consideration the peculiar geological and atmospheric data of the particular locality where the water is collected, stored and distributed. We will therefore explain some of the local conditions of this district.

The island of Hongkong is about eleven miles long and two to five miles in breadth, its circumference being about 27 miles and its area $28\frac{3}{4}$ square miles. It consists of an irregular ridge of lofty hills which stretch nearly east and west with but few valleys. The hills form a more or less central ridge along the eleven miles of length. They rise to a height of nearly 2,000 feet. The land is mostly of decomposed granite with granite boulders of various sizes. Very little is cultivated. Large areas on the South side and the East end are reserved for water catchment. Nearly half of the total area of the island is now catchment area, and can be used for no other purpose.

There are about 420,000 people resident on the island. The great majority live in the city of Victoria which is in places very congested. The more wealthy residents have houses on the Peak—the ridge directly above Victoria. There are a few villages—Aberdeen, Stanley, Shaukiwan, etc—where fisher folk and market gardeners have their homes.

The island of Hongkong was ceded to Great Britain in 1841 and the Kowloon peninsula and Stonecutter's Island were ceded in 1860. In 1898 the areas known as the New Territories were leased to Great Britain by the Government of China for a period of 99 years.

The total area now under the administration of Government of Hongkong is about 390 square miles.

An Engineer as Governor

Kowloon is a city of this century, situated across the harbor, directly opposite the city of Victoria. Its phenomenal growth has been

chiefly due to the comparatively recent great increase in the shipping trade on the Pacific Coast. The land on which this city is built was originally (before 1898) of varying levels but it is now practically a flat plain. The local Government carried out vast schemes of levelling, the soil removed being dumped into the sea, thus forming extensive reclamations.

The population of the city of Kowloon is now about 300,000. There are also some 100,000 Chinese, mostly engaged in agricultural or fishing pursuits, in the New Territories. A further 100,000 Chinese live on junks and sampans in and around the harbor, and various inlets near to villages.

The total non-Chinese population in Victoria and Kowloon is about 20,000. This number includes two British battalions and military auxiliaries such as gunners, engineers, doctors, etc., stationed for defence of British trade in the Far East.

It is of interest to note that the only engineer who has been Governor of Hongkong (Sir Matthew Nathan) visualized the possible development of Kowloon. He planned (in 1905) the remarkable wide highway that runs through the city and is called Nathan Road. He also carried out the project of the Kowloon-Canton Railway.

Fig. 8.—A Catchment Area in Hongkong

Administration and Climate of Hongkong

The daily administration of the whole area of 390 square miles is carried out by the twenty-eight Government Departments which are officered exclusively by members of the Civil Service. The officers for administration are locally known as "Cadets"; they are recruited from British Universities, Oxford and Cambridge supplying the majority. There are also a number of trained professional officers for legal, medical, engineering, financial and other work.

The climate of Hongkong is sub-tropical. The winter, usually, is cool and dry, and the summer months hot and damp. The N.E. Monsoon in winter, and the S.E. Monsoon in the summer, regulate to a great extent, atmospheric conditions.

The rainfall varies greatly throughout the year, and from year to year; an average annual rainfall is about 86 inches but there are records that show figures as low as 37.27 inches July, 1927—June, 1928 and as high as 156 inches (see Figs 3 and 4). Local experts consider the latter record a doubtful figure; but there are several records of over 120 inches.

The rains usually come in June, July and August, and are heaviest after typhoons. The typhoon season is from about June to October. The strong winds during typhoons often do great damage to buildings. For 1932 the maximum wind velocity was 79 m.p.h. when a typhoon was within 200 miles South of Hongkong.

Hongkong is situated in latitude 22°N. and longitude 114°E. The average temperature is about 72°F. ranging from 59° in February to 82° in July. Extreme temperatures of 97° and 32° have been recorded in August and January respectively.

The average humidity of the air is about 77 per cent of saturation, ranging from 66 per cent in November to 84 per cent in April. A minimum humidity of 4 per cent has been recorded, and it is assumed that saturation (100 per cent) is of fairly frequent occurrence.

The Granite Cone

The island, before the occupation in 1841, was practically a granite cone, projecting out of the sea and covered with a very poor growth of vegetation; nearly all of the flat ground has since been made by reclamation schemes which have cut into the hills and placed dumped earth into many square miles of the sea. The city of Victoria is situated on the N.W. coast of the island.

The general formation of the locality is granite hills, surrounding practically the whole territory, with some areas of flat cultivated land. On the mainland and in a few places on the island these small areas of flat ground have been partly caused by the continued washing down of disintegrated granite and organic material from the hills, and partly by the industry of native cultivators of the soil. The flat areas caused by the many works of reclamation have all been used for buildings or industrial purposes.

The granite formation of the locality causes the excessive moisture; the hot saturated air coming up from the South condenses as fog when it strikes the rocky cone. If the wind is from the North the air is dry and with but little humidity.

A little rice, but a small fraction of that consumed locally, is the principal article of cultivation, but there are areas of market garden cultivation on the outskirts of Kowloon. Most of the hills were formerly barren except for a sparse covering of coarse grass, but they now possess a very promising growth of pine trees planted in recent years by the Government. There are very few indigenous trees of any size except around some of the villages where they are preserved as shrines connected with native worship customs.

Public Works Department

The biggest spending department of the Government is that dealing with Public Works. Until a few years ago all of the expenditure in Hongkong—including new Public Works—was financed out of revenue. In recent years public loans have been raised to finance certain new schemes; that system has been repeatedly

urged by taxpayers, and especially in recent years to finance the costly construction of new waterworks, considered to be essential on account of the rapid increase in the population.

The loans are, however, almost insignificant (about a million pounds sterling) and Hongkong must be one of the few centers of world-wide trade that is practically free of public debt. The inhabitants are very lightly taxed, as compared with Britain, the ratio being possibly about one to five for a professional man.

The development of Hongkong has been due, very largely, to our increase in knowledge of applied science, although due credit must also be given to just and reliable administration as well as to the industry of the population. In 1841 there were, on the inland about 5,000 inhabitants, mostly pirates. Malaria and other diseases played havoc, especially with European residents in the early days, until remedies were discovered.

The evolution of steamships, the opening of the Suez Canal, and the general development of mechanical transport and communications, made the splendid harbor of Hongkong invaluable for foreign trade with South China. It is now, in respect to tonnage entered and cleared, one of the largest ports in the world. It is the distributing center, not only for South China, but for other parts of the world, such as Malaya, Siam, Dutch East Indies, etc. A pure and reliable supply of water is essential for the development of any large shipping center. In that respect, as in the matter of deep water in the harbor, Hongkong has great natural advantages over the neighboring Portuguese settlement of Macao.

Pure Water Available

The most important industries are those connected with shipping, such as docks and ware-houses, banking and insurance. Many of these were established between 1865 and 1872 but the number is being continually increased. A number of industries have developed in recent years in Kowloon, but the main cause of the growth of Hongkong has been the increase in shipping. The recent increase in tariffs in China has had an adverse influence on industrial development.

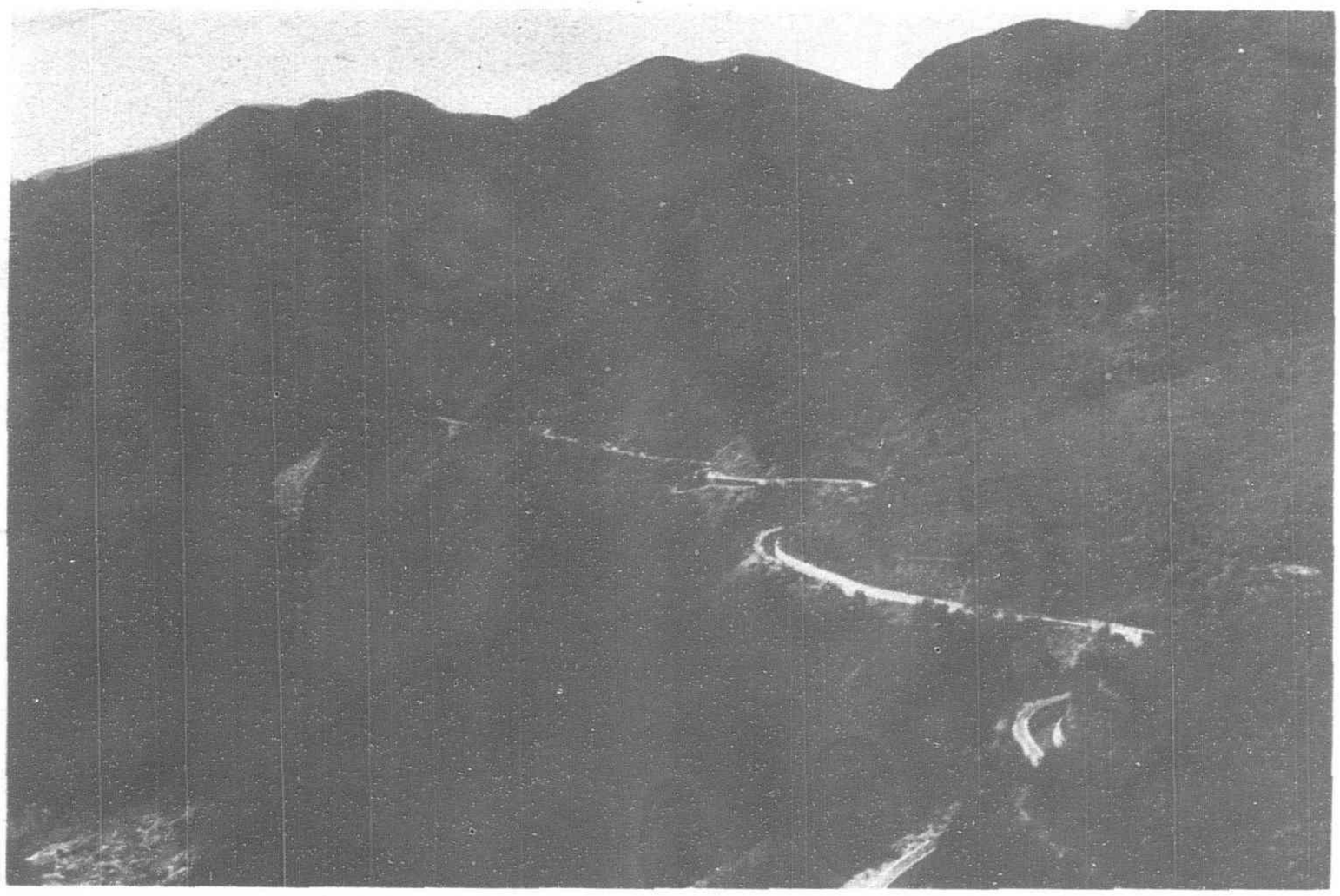


Fig. 9.—A Typical Catchwater in Hongkong carrying water from the Hills to the Reservoir

It must be obvious that, without a satisfactory supply of pure water, Hongkong could not have grown to its present dimensions. But in this century, the problems connected with that supply have been many and not easy of solution.

The Water Authority

The supply of water, the collection of accounts and all other details, such as new schemes, etc., is a Government undertaking. The individual responsible is the Director of Public Works, who is an engineer. He is a member of the Executive and the Legislative Councils. His department deals, of course, with other engineering works in addition to these connected with water supply.

It maintains the engineering services usually carried out in England by the Municipal Engineer.

The Director receives a salary of £1,500 rising to £1,800 per annum, with pension rights. The Assistant Directors rise to a maximum of £1,400. An Assistant Engineer commences at £550 rising to £1,150. All of these salaries are given in sterling and payment in the Colony is made in dollars at the current rate of exchange. The European staff under the Director consists of 155 officers; there are 557 non-Europeans on the staff.

One of the several sub-divisions of the Public Works department is the Waterworks Office. The staff for that Office consists of two Executive Engineers, one in charge of maintenance and the other construction; six Engineers; two Senior Inspectors of Works; three Inspectors; nine Overseers; one Diver and one Clerk.

That Waterworks Office is responsible for the construction of all new waterworks schemes (except the latest Shing Mun scheme) the operation and maintenance of the water supply system throughout the Colony, pumping stations, workshops, meter readings, issue of water service accounts, etc.

The new dam for the Shing Mun Scheme is being designed and constructed by London Consulting Engineers. The firm was, until recently known as Messrs. Binnie, Son and Deacon, but now is named Messrs. Binnie, Deacon and Gourlay. They commenced preparatory work in connection with the new dam late in 1932. Mr. Gifford Hull, M.INST.C.E. is their representative in charge of the work now under construction at Shing Mun.

Revenue Figures

It is of interest to notice that in 1932 the revenue collected by the Government from waterworks was, a total of $2,048,182 (Hongkong dollars). In 1931 it was $1,714,000. The revenue collected in 1913 was $404,220. Thus, in less than 20 years, the revenue obtained from the sale of water has increased nearly five times. But the expenditure on the new schemes has been relatively enormous.

The total revenue for Hongkong, in 1932, amounted to $33,549,716, and in that year the total expenditure of the Government was $32,050,283. Of that total expenditure more than 26 per cent viz., a sum of $8,437,090 was spent on Public Works.

Looking over the records of expenditure by the Public Works Department we find that the maximum figure occurred in the year 1925 when there was spent a total of $11,638,372. Of that sum (*a*) "personal emoluments and other charges" absorbed $1,346,091; (*b*) "special expenditure" cost $78,919 (*c*) "annually recurrent works" took $1,574,431 and (*d*) "extraordinary works" cost $8,638,930.

This last item included the expense incurred in making tunnels through hills in the New Territory in order to reinforce from the Shing Mun river the water supply for Kowloon and Hongkong. The total expenditure in 1924 on Public Works was $11,091,522—a considerable item being also in connection with the tunnels, and other preliminary work at Shing Mun.

The following table is of interest as showing the expenditure by the Government of Hongkong in various years on the Public Works Department.

In four or five years, about ten millions will be spent on the Shing Mun scheme, but it is proposed that only interest and sinking fund will be paid out of current revenue. Actually a great deal of the expenditure on water supply that was originally intended to be met from loans has been financed from unexpended balances in the local Treasury.

TABLE OF EXPENDITURE BY THE HONGKONG GOVERNMENT

Year	*Public Works*
1914	$ 2,621,205
1918	2,666,027
1925	11,638,372
1928	6,621,821
1930	8,478,094
1932	8,437,092

The chief source of the revenue of the Government is the assessment tax on inhabited dwellings which produced nearly 20 per cent of the revenue in 1932 viz. $6,332,066. The Military Contribution paid to the "home" Government was $6,559,239. It may be mentioned that the citizens of Hongkong contribute that sum for the defence forces in the Far East. British citizens in Shanghai and other parts of China make no contribution for defence.

A careful analysis of the expenditure by the Government of Hongkong reveals the fact that during the last twenty years the cost of new works and extensions for water supply in Hongkong must have exceeded twenty million dollars. Of course the results have more than justified the cost. The estimate of costs of the new works being carried out at Shing Mun is 10 million dollars.

These figures may seem very low, especially if translated into sterling at the present rate of exchange, but of course exchange has fluctuated greatly. It was over 6/3d. in 1919 and 10½d. in 1931 ! (see Fig. 6).

However it may be stated that, as compared with cost in Europe and America, the actual total cost at an average figure of exchange is extremely low. That is because the cost of labor—a very big item in this class of work—is extremely low in China. And cement is now relatively cheap in Hongkong, there is any quantity of granite available for concrete. That enables civil engineering work to be carried out cheaply in this part of the world. On the other hand in spite of cheap labor, as will be seen later, mechanization has been employed in the construction of the latest dams and, owing to great improvements in machinery, it has been found that it pays to put power behind the worker on big civil engineering works even in China.

Life Lengthened in Recent Years

One of the problems that must be taken into account, in arranging for a constant supply of water, is the method of ensuring purity. This is done by filtration, etc. It must be insisted upon that purity is essential in the interests of public health.

One of the most remarkable facts, proved beyond doubt by statistics, and most apparent to careful observers, is that the span of life of the average man in Europe and North America has in recent years increased in a remarkable manner.

We may argue as to whether man, in the last fifty years has become more or less pugnacious, more or less philosophical, than he was. We may even have different opinions as to whether he is happier, and more moral, under the modern conditions created by the engineer, than he was in the pre-power era. Such matters can be argued. That he is more healthy there cannot be a shadow of doubt. It can be proved beyond cavil.

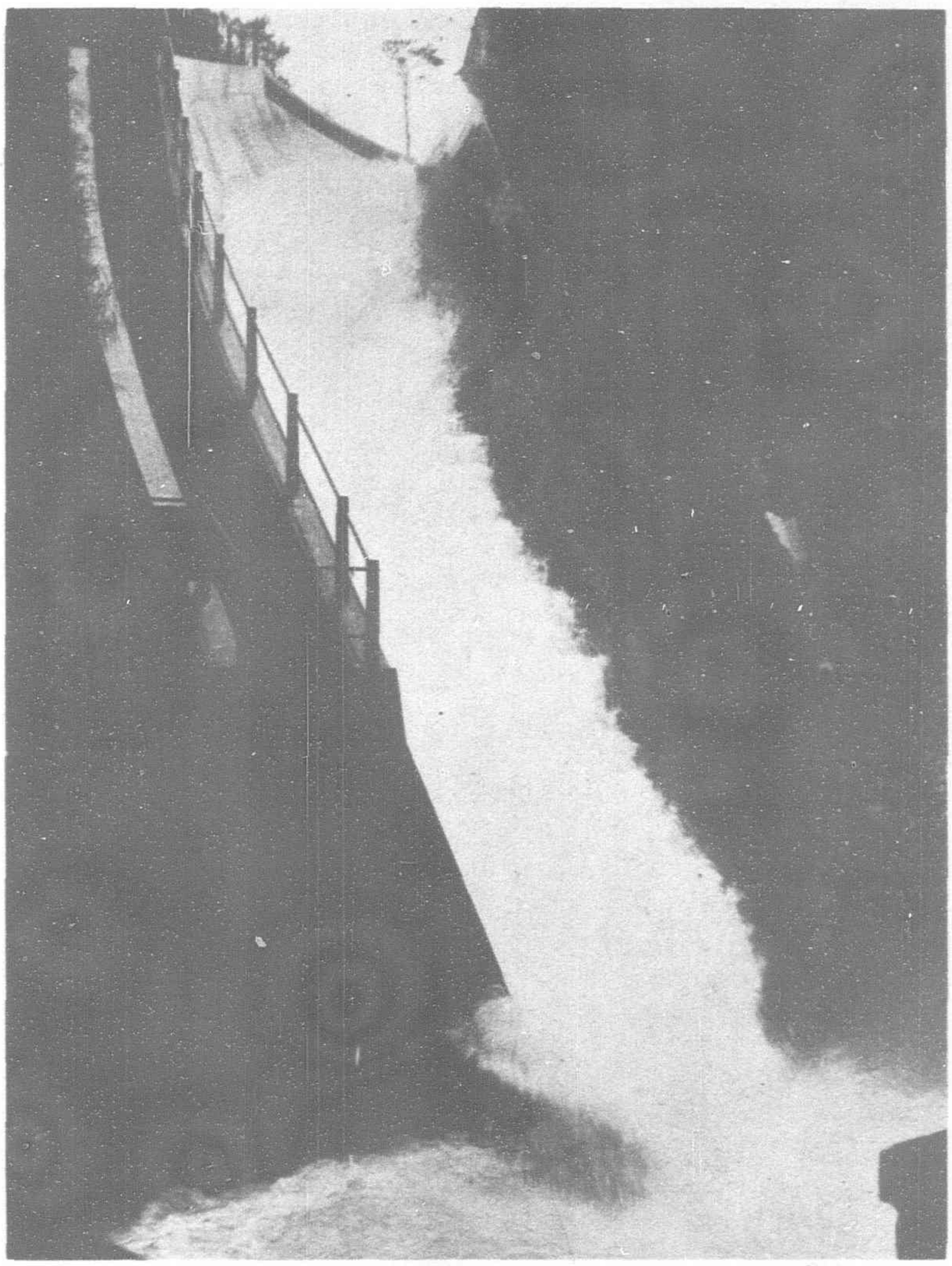


Fig. 9A.—The Stanley Mound East Catchwater Outfall into Tytam Tuk Reservoir

The whole impact of modern science upon human life has produced a fundamental and startling revolution in the conditions under which we live. The engineer and the doctor (as shown in the issue December, 1933 of the *Far Eastern Review*), have supplemented each other's struggle on behalf of public health. The creation of a higher standard of living by the use of power production has had no small part in affecting for the better the statistics about life. The material prosperity of the common man in England and North America (a startling contrast to the poverty of the common man in China), is the fruit of applied science.

For in those countries, where the new knowledge is fully utilized, one-third of the total burden of disease and death which weighed upon the inhabitants fifty years ago has been lifted from their shoulders. From 1838 onwards we have official data about the length of life in England. Over a period of about fifty years after the figures were recorded the average span of life increased, in that country, eight years. In 12 years (1910-1922) it again increased eight years. In about 1850 a man might expect 40 years of life ; in 1922 he could expect 56 years. We know that there has been an increase since then.

Pure Water Essential for Health

One of the most important causes of the prolongation of the average length of life in these countries which makes use of applied science has been the provision of pure water. Typhoid fever (and other diseases that attack the digestive apparatus) can usually be traced to impure water.

In 1924 one of the small reservoirs in Hongkong became contaminated. There was a

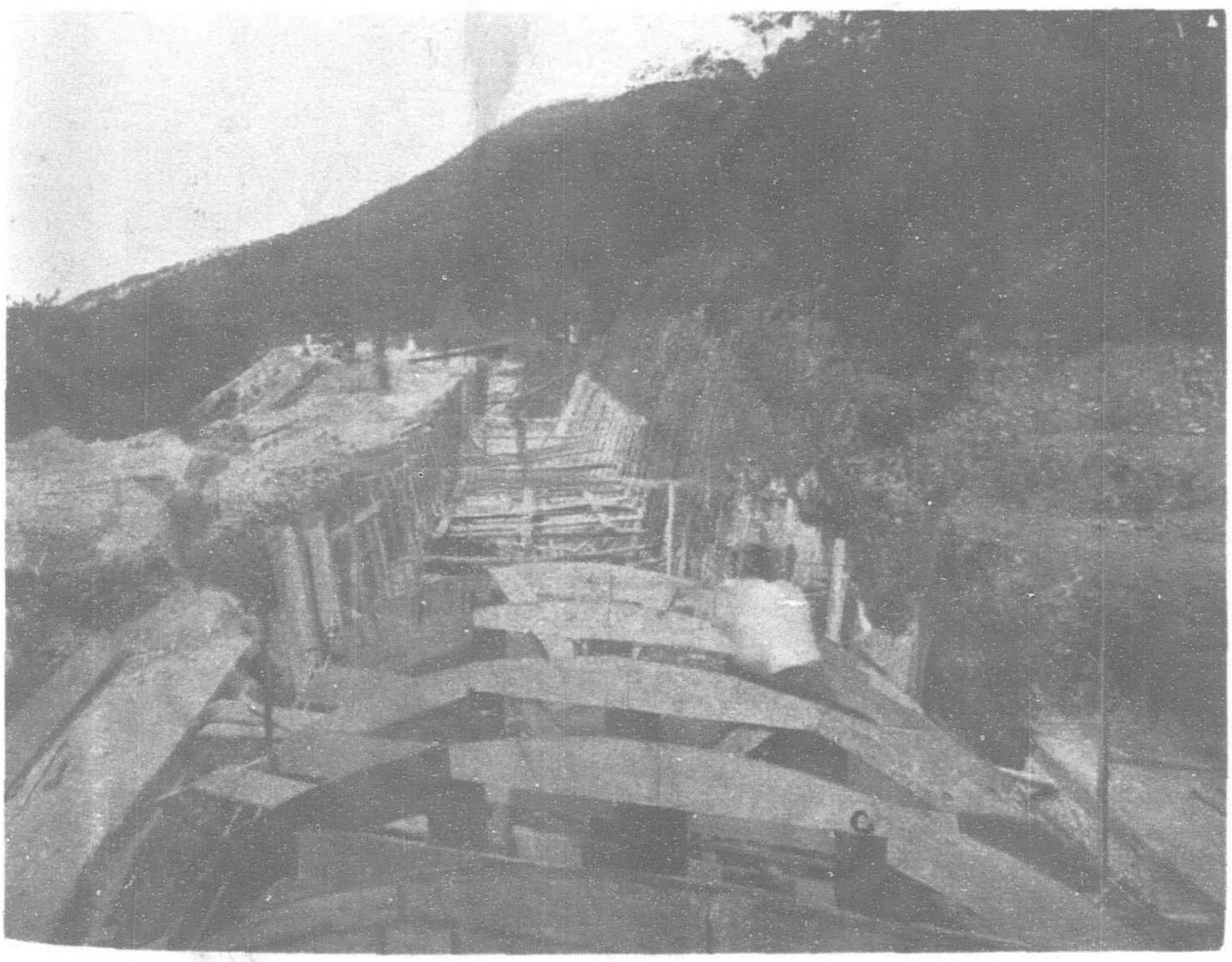


Fig. 9B.—A Hongkong Catchwater in course of construction

typhoid epidemic that left its terrible record of graves in the Happy Valley. At the time it was suggested that the cause of the trouble was contaminated milk, and some people said that the milk was contaminated because the bottles were washed with contaminated water. It is unlikely to happen again, as the lesson of the need of careful supervision of the water storage will not be easily forgotten. But the water supply for any town must be absolutely pure.

Many years ago, the area that is now covered by the metropolis called London (with its 8,000,000 inhabitants), was a collection of villages, isolated from each other. Each of them was built over a patch of water-bearing gravel. It was only possible for the gaps between the villages to be covered with houses when some more general supply of water than that from wells in the gravel was supplied.

To-day every house in London has a constant supply of pure water. It is an enormous undertaking, but it is recognized by the community as of paramount importance. An army of officials is employed in the work of maintaining an adequate and pure supply. The river Thames is the source, but there are many complicated problems concerned with the purification and the financial details of supply.

As long as houses were isolated, or only in very small groups, the supply of water could be obtained from a spring or a stream.

But when people began to settle in towns and cities the dangers of a crude system of water supply became great. For without a water supply, in nearly all cases, there is no proper drainage and no efficient means of preventing sewage and filth from percolating into shallow wells and streams.

The first effort to introduce the European, or modern system, of water supply was made in Hongkong in 1863. In the month of August, 1881, works were commenced in Shanghai to supply water to the International Settlement. Li Hung-chang, then Viceroy of the Province of Chihli, inaugurated the public service in August, 1893. The source of supply is river water which, after treatment, is pumped to a water-tower to obtain the pressure needed for distribution.

Since that date more extensive works have been carried out in the Far East. In South China Canton, Amoy, Wuchow and Nanning now have modern systems of water supply.

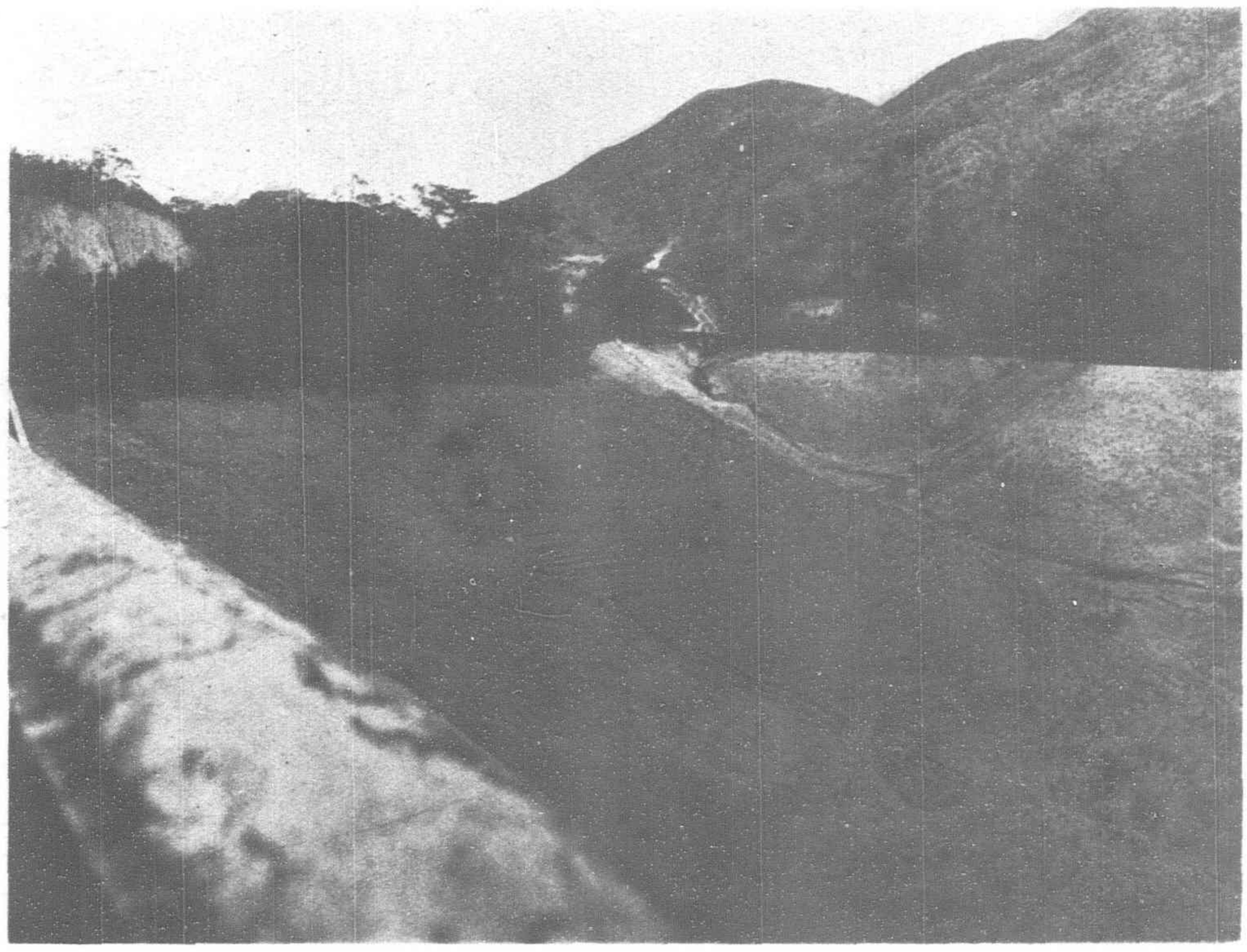


Fig. 10.—Tytam Tuk—Showing Stanley Mound East Catchwater Outfall Entering Reservoir almost dry

The Romans and Aztecs

There is ample evidence that in the earliest civilizations in the West, the importance of an adequate water supply was realized. The Romans, especially, not only in their own country, but in the countries which they ruled, worked out magnificent and bold schemes of water supply. They must have had very capable engineers. They carried water for miles along aqueducts, maintained at the best level for a suitable flow of the stream (Fig. 7). It is curious, however, that, expert engineers as were the Romans they seemed to be unaware of the fact that water can be made to flow uphill (as well as downhill) if there is sufficient pressure of water behind the stream, which must, of course, be enclosed in a pipe able to withstand the pressure due to the head of water producing it.

When the Roman Empire collapsed, questions of water supply were neglected. The terribly high death-rate in Europe in the middle ages, as well as the awful epidemics which decimated, and more than decimated, the populations of whole villages, towns, and countries, was due to that neglect of water supply.

The arrangements for the supply of water in Mexico and Peru, under the Aztec civilization, were much superior to those of Europe in the sixteenth century. But when the Spaniards conquered those countries all the monuments of their early civilization went to ruin. Yet the evidence that remains proves that, in the history of the world, until that time, their work in connection with water supply was eclipsed in granduer only by that of the Romans.

The Example of Japan

Three centuries ago Tokyo was supplied with water. The Tamagawa canal, supplemented by a complete system of ingenious wooden pipes of square section, provided that city in the beginning of the nineteenth century with a water supply superior to that of either London or Paris.

Incidentally it may be mentioned that wooden pipes were also used for the distribution of water in London up to about 1820.

Cholera in Yokohama

In the early part of 1883 the Japanese Government, with the assent of the British authorities, requested Major-General Palmer, R.E., to prepare a scheme and act as Engineer for a system of water supply to Yokohama.

And so in October, 1887, there was completed the first European system of water supply and distribution in Japan.

"It was"—said one of the British engineers concerned in the work "naturally regarded by the Japanese public as a crucial test of the efficacy of this phase of sanitary reform in the peculiar climatic and other conditions that prevail there."

At that time (1887) the population of Yokohama was about 190,000 people. And the houses were of timber—resulting in many fires.

Before the European system was introduced the population drew all water for domestic purposes from shallow wells sunk in the gravelly subsoil of the town. And owing to the absence of a good drainage system, these wells were extensively polluted by the infiltration of water already fouled by use.

Recurrent epidemics of cholera forcibly directed the attention of the municipal authorities to this unsatisfactory state of affairs. An official investigation proved the close connection between polluted water from wells and the virulent development of choleraic disease. And it was therefore decided to introduce a high pressure water supply for Yokohama.

A gravitation supply from the Sagami River, at a point 28 miles from Yokohama, was decided upon and carried out. An aqueduct, 27 miles long, was built from the intake works at the river to the service reservoir at Nogeyama. Some nineteen conduit tunnels and miles of 18 inch cast iron pipes formed this aqueduct; for the last eight miles a 15½ inch pipe was used.

English Cement

When we remember what a vast quantity of cement is now manufactured in Japan—and much of is exported—it is surprising

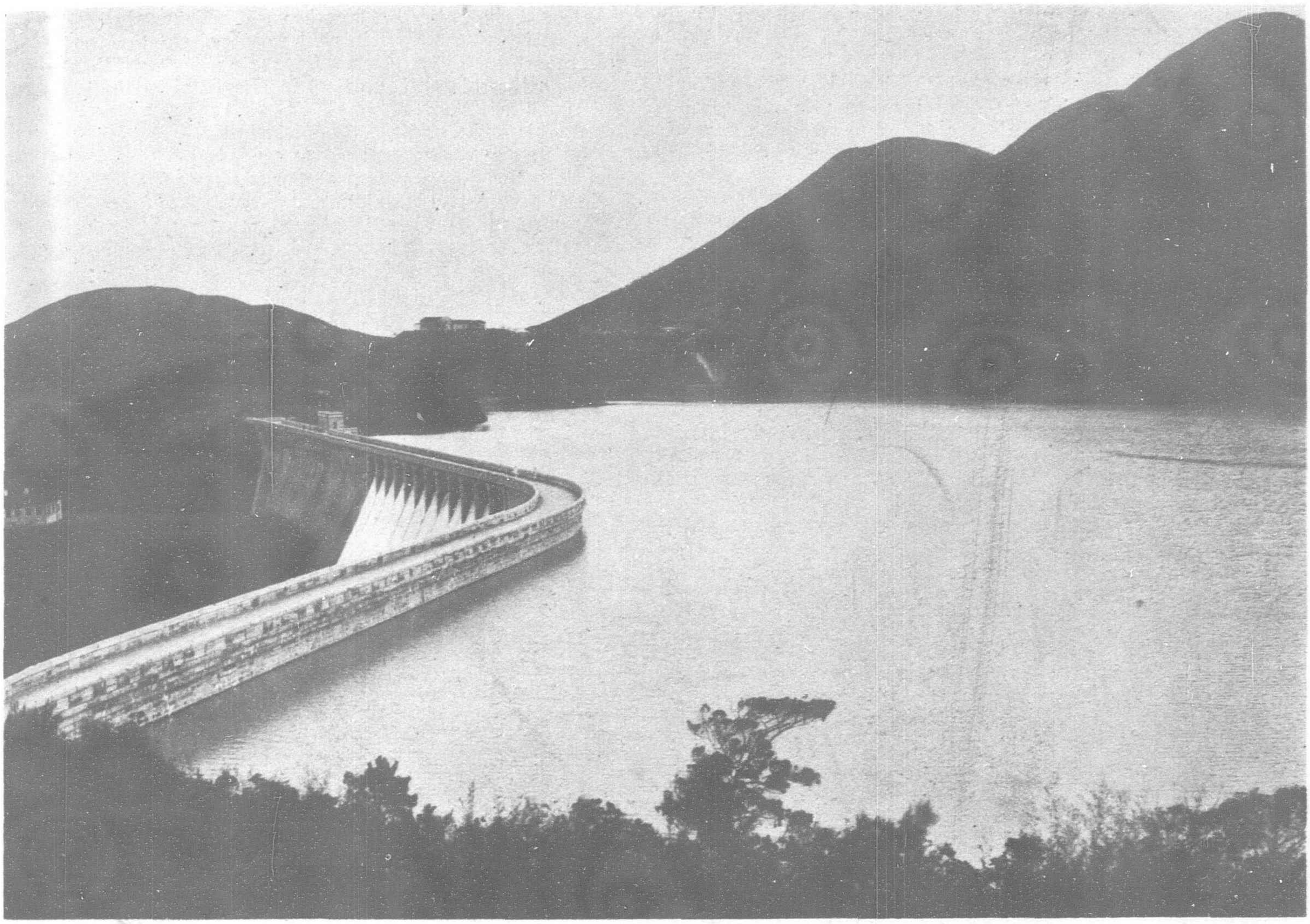


Fig. 11.—The Tytam Tuk Reservoir at overflow

to learn that the cement used on these works was imported from England.

The whole cost of the works was about £177,000. The average cost of water was nine pence per 1,000 gallons. The pressure in the mains was between 60 and 70 lb. per square inch.

It is now generally believed that the supply of water should not be in the hands of private individuals or companies but that it is a matter either for the state or the local municipality.

In that connection it is of interest to record that in 1933 and in 1934 there were, in many parts of England, periods of water famine. Indeed, in February, 1934, Parliament voted £1,000,000 to alleviate the hardship caused by the droughts in rural districts. There has been a very determined agitation to place the control of the water supply of the whole country in the hands of one central authority and to take it away from the various municipalities and private companies that now are responsible for the supply.

The acknowledged success of the electric "grid" system in Britain helped the agitators. For Parliament, some years ago, legislated that the provision of cheap electricity was of such vital national interest that the problem must be solved, and all details concerned with it, decided, by electricity Commissioners. The result is a gradual transformation of the whole system. The Commissioners are planning, and operating, super-power stations, and eliminating small and inefficient generating plants: at no distant date there will be a cheap and reliable supply available for every town, village, hamlet and farm or cottage in the country. The supply will never fail, for if one power station has a disaster, others supply the "grid" with electrical energy.

A National Water "Grid," Supply

The demand in Britain to-day is that there shall be similarly, a water "grid" all over the country. Already the city of Birmingham, with its 3,000,000 inhabitants in the center of England brings its water supply from the mountains of Wales, seventy miles distant. Manchester and other cities rely upon water collected from mountains equally far away. It requires no great effort of imagination to realize the great advantages of a Central Water Authority for the whole country.

As far back as 1878, the Prince of Wales, as President of the Society of Arts in Great Britain, wrote to the Council of that Society, stating that the supply of pure water was exciting great interest throughout the country, smaller towns and villages being dependent on accidental sources of supply often entirely inadequate for health and comfort. He considered that great public good would result from the adoption of some large and comprehensive scheme of a national character, whereby the resources of water supply might be turned to account for the advantage of the general body of the nation at large.

For fifty-five years the majority of water supply engineers in Britain have been in favor of co-ordinated national action and treatment in this matter.

In continental countries in Europe rainfall and stream gauging are national services. Water supply, the most vital of all public services, demands national co-ordination.

We cannot expect that a national system of water supply can be planned, and carried out in the near future, in China. But as each of the eighteen provinces of China is more or less the size of Britain, it would seem that each Provincial Government should organize engineering schemes for the province, almost independently of other provinces. Of course there should be general standardization all over China, but the finance and general organization of Public Works should be decentralized to each province with general supervision of a Central authority to ensure standardization.

Unfortunately the present state of China renders it unlikely that such an ideal organization will be realized in the immediate future. We must therefore encourage every city, town and village

to reform its own water supply working, as far as is practicable, in collaboration with neighbors.

Although, primarily, the supply of water is undertaken for health reasons, there is no reason why ultimately a profit should not be made by the supplies if the scheme is properly planned, financed and efficiently carried out. Consumers who use water other than for domestic purposes, such as in manufacturing processes and for gardens, or fountains, can be charged at extra rates.

Quantity of Water

The supply of water in Hongkong for the island and Kowloon, has presented many unusual problems. The chief is the storage of sufficient quantity to supply nearly a million people during a long dry season.

The lack of water during the winter months is not due so much to inadequate total annual rainfall, as to unfavorable distribution throughout the year. Precipitation is largely confined to a few months; after that the slight rainfall is almost entirely lost by absorption into the ground. A further complication is that the total rainfall from year to year varies. That means, of course, that provision must be made for the probable years of comparative drought. For that reason reservoirs of large storage capacity have been built.

There are now no wells in use for drinking water, but some are used to supply other demands such as sanitation, etc. In the early days of the Colony, before there was a public supply, wells were used for drinking water.

In addition to the rainfall there is collected a certain amount of water from seeps and springs. In the driest seasons you may find streams trickling water. But that supply is insufficient to meet with demand in the long dry season.

Quantity of Water Required

The amount of water used per head of population per day varies greatly in different cities. The records are affected by the supply available, habits of the inhabitants, the nature of industries in the district and the precautions taken against waste.

In England the system of charging for water is simple. Each dwelling is assessed at a certain rental, and a water rate, at a certain percentage of the annual rental, is levied (Extras for such additions as garden hoses, are charged). There is, with this system, no check on waste. On the other hand cleanliness is encouraged in the most lowly dwellings.

The Hongkong water engineers favor the system of house meters as a safeguard for limiting the quantity of water consumed each month. They say that with that system people take care that taps do not leak and are not left running water to waste.

For all, except special trade purposes, the mean consumption in a certain town with water closets, worked out at a figure as low as 12½ gallons per head per day. In some American towns the figure recorded has been 120 gallons. There is an enormous difference in consumption in different cities.

An average of 30 gallons is considered a fair supply. A generous supply is 40 gallons. Trade and manufacturing demands for water in bulk are extra; and for several industrial towns the latter demand works out at about five gallons per head per day, in addition to the average 20, 30 or 40 gallons considered enough.

During hot and dry weather the consumption for domestic purposes is greater than in cold weather. In the tropics people bath more frequently. It is a fortunate occurrence that, generally speaking, the rainfall is greatest in Hongkong in the hot weather. But sometimes there is a spell (March to June) of warm weather and no rain and then there is anxiety in the water department.

When a new waterworks is started it is difficult to estimate with exactness the quantity of water needed per head per day. Experience over years gives data.

But far more difficult is it to estimate the margin that should be allowed for an increase in population. And in Hongkong the rapid growth of numbers could never have been foreseen.

During the whole year of 1932 a total of 3,517 million gallons was consumed on the island of Hongkong—population of about 400,000—averaging about 24 gallons per head per day. But the London area consumes 300 million gallons a day (about 30 times as much) for a population of eight millions—say an allowance of 38 gallons per head per day in London. Glasgow and several American cities use as much as 100 gallons per head per day.

The Quality of Water

In Hongkong there is practically only one method of public water supply—from reservoirs and (except in occasional outlying residences) after it is filtered. Suggestions have often been made that sea water should be pumped up to a reservoir and a second system of pipes installed so that salt water could be used for flushing, fire and road sprinkling purposes.

As the suggestion was not accepted in the worst period of water shortage (and storage) it is not likely to be revived now that a new huge scheme of storage is being carried out. But there is something to be said in its favor, although there are perhaps better arguments in opposition to the scheme.

In any new plan the geologist can advise as to the freedom of the supply from any sources of contamination and the prospect of hard, soft and saline waters. But, once the supply is in service, the chemist and the bacteriologist must determine the mineral ingredients and the organic impurity. That, it is scarcely necessary to add, is frequently and adequately done in Hongkong.

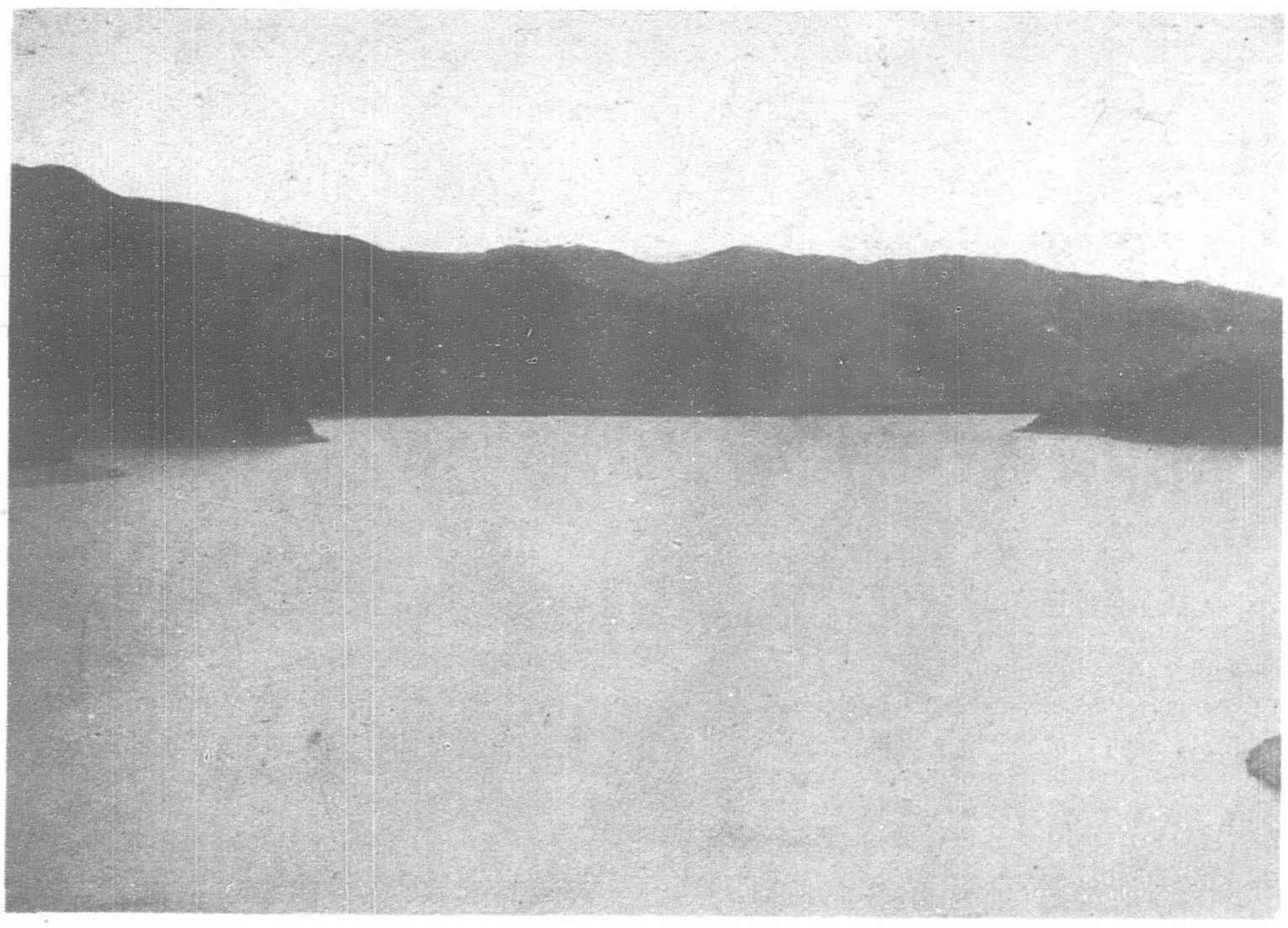


Fig. 12.—Tytam Tuk Reservoir nearly full. Looking on inner face of the dam

Bacteria, dust, various wastes of life, and organic and mineral substances are washed off the land of any area supplying reservoirs. For that reason an elaborate system of purification is needed before the water reaches the consumer's house.

The various processes of purification can be divided into two main classes (1) those for the removal of suspended impurities (2) those for the removal of dissolved impurities.

In the first class the processes used are sedimentation and filtration. During sedimentation the suspended matters, including bacteria, settle out. The efficiency of the system depends on the time available. The process is often aided by some chemical. In Hongkong the water is chlorinated.

Filtration is usually accomplished by means of an artificial sand filter beds. That method has been used from the earliest times in Hongkong, but recently mechanical filters have been also employed.

Of course no method can be as certain as distillation, but the expense of that method is too apparent to make it feasible for a big city.

Fig. 13.—Effect of the long months without rain in Hongkong showing Tytam Tuk Reservoir beginning to run dry

It must be remembered that the object of water purification for domestic purposes is essentially to prevent the transmission of disease. Boiling water does that. It is obvious that the habit of drinking tea, and not unboiled water, in China must be a great preserver of health.

Rain Figures

Clearly the volume of water that must be stored will depend upon the local rainfall conditions. From year to year these vary, but there are now valuable records of what has happened in the past. So that some estimate of what water may be obtained from rainfall is possible.

The amount of water collected throughout the year in Hongkong is almost entirely dependent on the rainfall as there is no river of any great volume available. Unfortunately the rainfall not only varies considerably from year to year, and from month to month, but it varies also in different parts of the Colony.

Certain large areas of land on the island and the mainland are reserved as catchment areas. (Fig. 8) in effect the rain runs down the slopes of those catchment areas into small natural streams or into channels built for the purpose (Nullahs they are called locally) and thence into catch-waters (Fig. 9), and from them the water runs by an outfall into the reservoir. An outfall is shown in (Fig. 9A). A catchwater during construction is shown in (Fig. 9B) and in the far corner of (Fig. 10) you can distinguish an outfall bringing a tiny stream into the almost safety reservoir in the 1929 drought.

These reservoirs are situated at various parts of the island and mainland.

During a wet season the reservoirs often overflow ; the Tytam Tuk reservoir in Hongkong is shown at overflow (Fig 11). It is not quite full in the view shown (Fig 12) and the reservoir is shown with its water much lower (Figs, 13, 14 and 15).

The Hongkong dry season is usually from about the beginning of October to the end of February. The heaviest rains are generally in June, July and August, but throughout the Summer there are often at irregular intervals periods of considerable rain. The storage problem, the size of reservoirs, etc., however, is affected by the comparatively long (annual) period of but little rain in the winter.

It has been the unfortunate experience of the inhabitants of Hongkong that, on many occasions, restrictions of the hours of water supply have been enforced during the dry season. That was evidence that the storage capacity of the reservoirs did not keep pace with the increased demand for water. Indeed, a visit to the biggest storage reservoir in Hongkong, viz. Tytam Tuk, in the driest season revealed what little storage water was available.

During recent years it has been impossible to maintain the constant supply of water throughout the city and the island. Formerly when the restrictions were in force the " Rider " mains were brought into action. This means that there was no supply for certain houses in some of the districts of the city. Water was, however, available at stand pipes in the streets. Rider mains no longer exist as such. Supply is now restricted by control at the service reservoirs.

The Dreaded Droughts

During 1932 a constant supply on the island was maintained for 273 days, but for the rest of the year the water supply was cut off at certain periods of the day. The usual arrangement during restrictions is a supply from 6 a.m.—11 a.m. and 4 p.m.—9 p.m.

The average annual rainfall for Hongkong may be taken as about 86 inches. The figure for 1932 was 91.47 inches, being 11.08 inches more than for 1931 ; and 5.85 inches more than the average for the past forty-nine years. In 1932 practically all of the useful rainfall occurred in June, July and August when in three months 71.89 inches were recorded, as compared with 18.58 inches in the other nine months.

Until the rains came, early in June, there was a short period of intense water restriction, but there was so much rainfall in June and July of that year that by the first day of August Tytam Tuk reservoir was overflowing ; so that the 20.89 inches of rain that fell in August did not help very much.

Mr. T. F. Claxton, F.R.A.S. contributed some interesting data concerning the great drought in Hongkong to the *Hongkong University Engineering Journal* of June, 1930. The curves shown in figures (3) and (4) were compiled by Mr. Claxton. They show the average monthly rainfall for different period of drought.

The total rainfall from July 16, 1928 to June 13, 1929 was 27 inches against an average for those (nearly) eleven months of 71 inches; that is there was a shortage of 44 inches.

There have been other serious droughts in Hongkong; a deficit of 25 inches below average was registered from August 28, 1886 to July 4, 1887.

The total rainfall for the whole year 1895 was 45.83 inches, the lowest on record, until the 12 months July—June of 1928-9; and as much as 156.57 inches was recorded on the island for 1925 at Wong Nei Chong gap. It is only fair to add that it has been suggested that the rain gauge was considered unreliable and probably a lower figure—say 140 inches is near the record.

The curves (Figs. 3 and 4) show the abnormal rainfall in January, 1887 and again in February, 1896 as a matter of curious interest.

1933 was an anxious time for the water authority. The reservoirs were nearly empty (Fig. 10). From September 1, 1932—May 31, 1933 only 16.65 inches of rain fell in the nine months, against an average of 40.66 inches over 50 years.

In July the outlook improved, but 1933 provided a new record; for only 1.74 inches fell in August which completely eclipsed the 1906 record of 3.97 inches.

It is a curious fact that not only does the local rainfall vary for each month, but the fall for each month varies at different points of the island and in the New Territory. Thus, in July 1922, the rainfall recorded at the Royal Observatory (Kowloon) was 12.8 inches while that recorded at Wong Nei Chong reservoir on the island was 25.31-in. At Tai Tam Tuk reservoir on the island (Fig. 11), not very far from Wong Nei Chong reservoir, the rainfall recorded was 14.87-in. The maximum rainfall in the Colony occurs in the hilly watershed of the Shing Mun river.

The "Bruckner" Weather Cycle

The existence of a periodicity, known as the "Bruckner" weather cycle, has been recognized in Europe for several centuries and there is a reference to it as far back as the sixteenth century in the writings of Bacon. The exact length of the cycle has not been determined, but is assumed to lie between $33\frac{1}{2}$ and $35\frac{1}{2}$ years. Measurements have been made of the growth rings on the "Giant Trees" of California and they show that the weather cycle has prevailed there since about 1,000 B.C.

The London *Observer* newspaper in January, 1929 drew attention to the cycle by suggesting that as January, 1861 gave almost Arctic conditions in London, and 35 years before that, in January, 1826 the same conditions prevailed, Londoners must expect (what actually did take place) similar cold weather conditions in 1929.

Whether the "Bruckner" cycle applies all over the earth, or in the Far East we do not know. But my colleague, Professor F. A. Redmond, in April, 1929 wrote of Hongkong "In view of our depleted reservoirs it is interesting to enquire what, if it does apply, we may expect in the matter of rainfall this year."

It may be of interest to tabulate the monthly rainfall of the months of the years 1895 and 1929 and the average of 25 years 1884-1929 (approximate figures).

Monthly Rainfall Figures (inches)

	1895	*1929*	*1933*	*Average 1884-1928*
January	0.4	1.0	0.48	1.5
February	0.8	0.6	0.10	1.8
March	1.4	0.5	1.02	3.0
April	2.6	1.6	1.91	5.7
May	5.6	6.6	4.51	12.0
June	4.9	4.2	16.44	15.6

Incidentally it may be mentioned that the last six months of 1928 gave a rainfall well below the average of the 25 years 1884-1929 (see Fig. 4), but that the last six months of 1929 was noticeable for heavy rains. But in 1895 the whole year was well below the average rainfall (45.8 inches against average for 1884-1928 of 85.7 inches) so that the cycle fits as about 33 to 34 years in this case. But the average for nine years, in Hongkong before the drought (1920-1928) was 94.15 inches, nearly 10 inches above the average of 1884-1928.

It was the knowledge of this Bruckner cycle that made the Hongkong engineers urge more storage for 1929. Let us hope that in 1963 there will be ample storage, whatever may be the population of Hongkong at that date!

The result of observations on rainfall show that, in many countries, with climates otherwise very different, two phenomena are repeated with remarkable regularity:— (1) The minimum rainfall in the dry years is less than the mean, or average rainfall, over a long period of years by 33 per cent, whilst the maximum rainfall in a wet year exceeds the mean rainfall by 33 per cent.

(2) There may be expected to occur, at considerable intervals, sets of three consecutive years during which the average yearly rainfall is only 80 per cent of the mean yearly rainfall over a number of years.

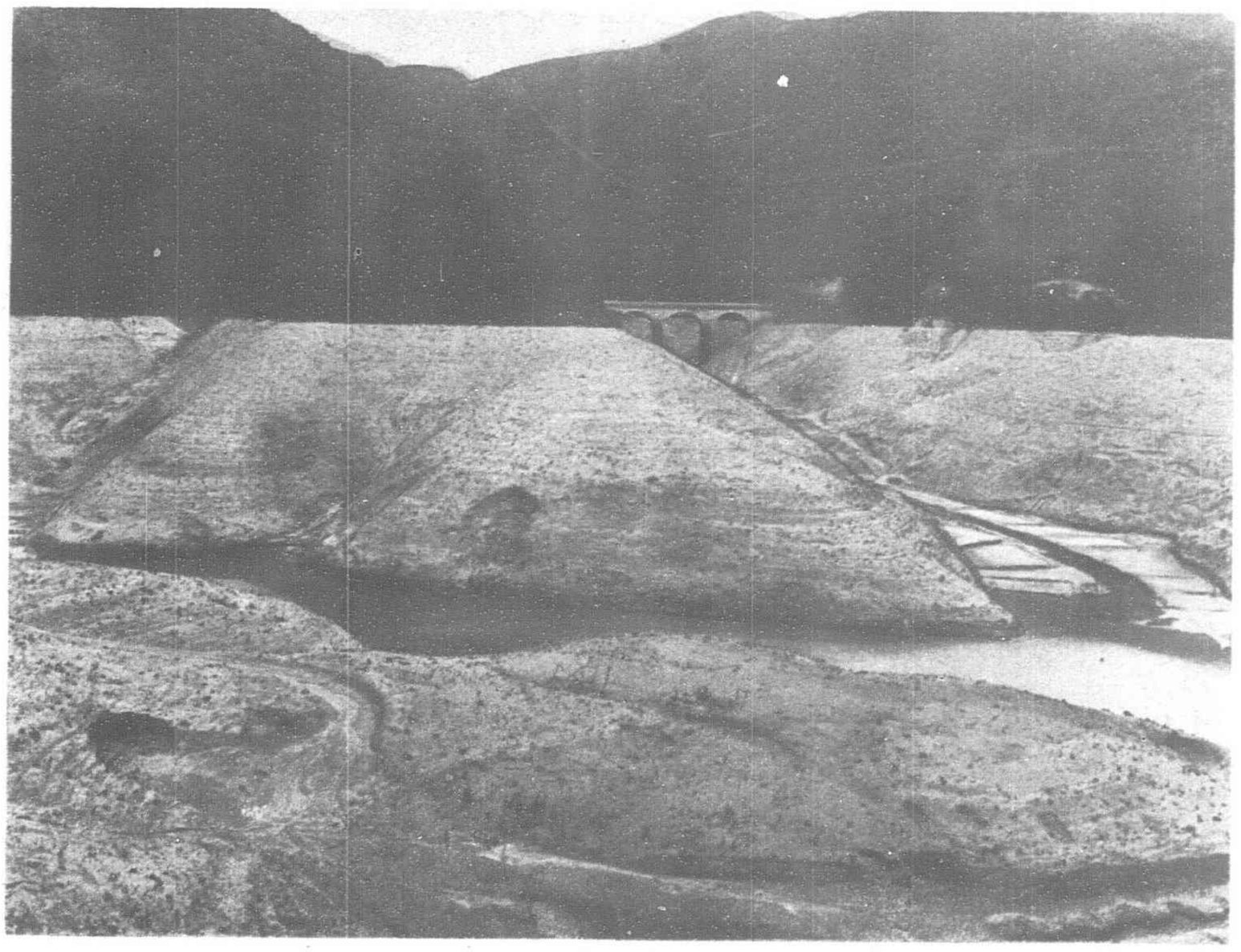


Fig. 14.—Hongkong's largest Reservoir practically empty during a drought

Typhoon Rains

There is another interesting feature about the total rainfall of Hongkong for the various years. The variation in places is not consistent. Comparing decrease in rainfall for 1922 with that of 1921, we find that it was 30.68-in., as registered in the Public Gardens, Hongkong Island, and 8.54 as registered at Tai Tam Tuk reservoir, also on the island.

Thus, when in 1925 at the Wong Nei Chong Reservoir 156.59 inches of rain was recorded, at Taipo (in the New Territories) the record showed 117.02 inches, and at the Kowloon reservoir the figure was 111.76 inches.

In 1925 the rainfall for the year, recorded in Kowloon at the Observatory, was 106.74 inches, or 37.31 inches more than was recorded at the same place in 1924 and 21.96 inches above the average for the forty years previous. But it was about 50 inches less than the Wong Nei Chong gap record for that year.

A heavy rainfall in Hongkong usually comes after the passage of a typhoon near the island. In May, 1889 some 3.4 inches of rain fell in one hour and $27\frac{1}{2}$ inches was recorded during 24 hours. Mr. G. T. Symions (Proc. Inst. C.E. Vol. C.P. 311) gives the Hongkong Observatory record for 24 hours, ending 6 a.m. May 30, 1889, as 28.44 inches "being" he adds "considerably more in that one day than fell in London in an average year"; as much as 3.4 inches

had been recorded in England for one hour but "the special characterists" (of the Hongkong record) "was the long duration of an intense fall."

Mr. W. St. John H. Honcock, C.E., estimated that the total weight of water that fell on the Colony was five and a half million tons, or 1,225 million gallons. Between 7 a.m. and 10.20 a.m. the rainfall was 5.2 inches and between 10.20 a.m. and 12.30 a.m. it was 6.4 inches, or 11.6 inches in all in 5½ hours. Huge drains failed to carry away the flood, and one became so congested that, for some yards, the road was torn up and great blocks of stone were thrown aside as if they were straws. The roads were impassable and every lane was a channel filled with rushing yellow water. It is said that, in April, 1931, as much as five inches of rain fell in one hour not far from Kowloon.

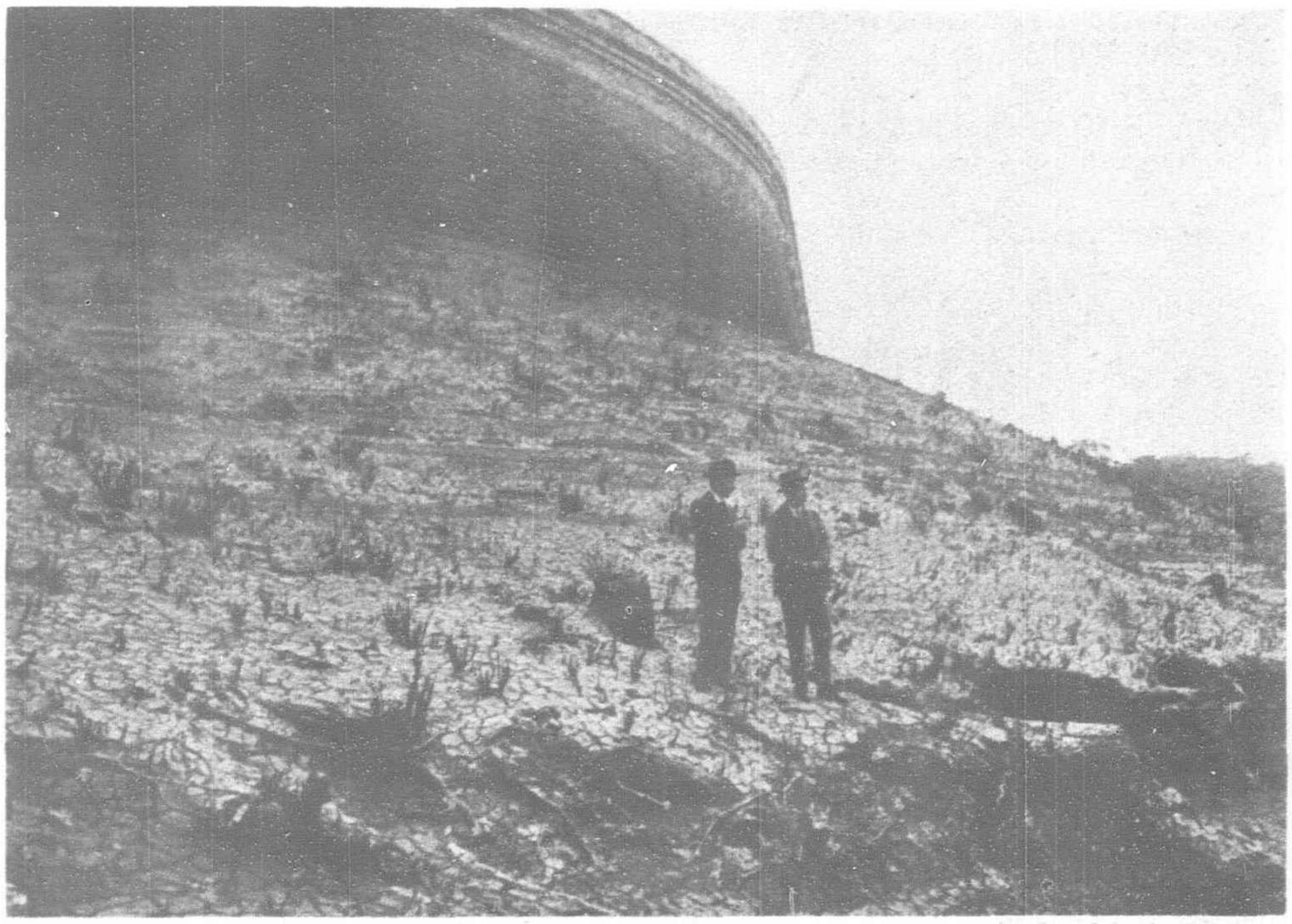


Fig. 15.—Tytam Tuk Reservoir empty during drought. The water usually reaches near top of the wall

In 1926 there was a terrific rainfall. An enormous boulder, estimated to weigh about one thousand tons, slipped down the hillside. It fell with increasing momentum, to a level about 100 feet below where it started, and it crashed on to the pumping station that supplies water to the Peak district. It completely wrecked a part of the machinery in the station and made the supply of water to the Peak impossible for several days.

The Separate Services

The work of the Water Authority is divided into two main sections viz., the supply of water in the island and the supply of Kowloon.

It must be remembered that the Water Authority has not only the maintenance and repairs of all existing plant, but has had also to plan out the extensions and (except for the Shing Mun dam) supervise the construction of all new works, such as reservoirs, catchments, etc.

It is only since 1910 that there has been a water supply from reservoirs in Kowloon. Previous to that date wells were used. This huge residential area on the mainland is enlarging rapidly. At present the population numbers more than 300,000. But the water engineers must plan for an increase in those numbers.

Let us consider the principal problems which the Public Works Department in Hongkong have had to solve during the period of about seventy years since the Government undertook the supply of water to the public.

In the early days (1863), when the population was comparatively small, and a reasonable supply of water per day per head of population was considered to be about five gallons, as against the twenty gallons now assumed to be necessary, nobody supposed that there would be any problem, except finance, to consider.

The island contained large areas of land not built upon and very suitable for catchment areas. The city was practically on sea level. It was obvious that storage could be provided in a reservoir, or reservoirs at such a height above sea level that water would flow by gravity to the various points of distribution.

But the population of Hongkong rapidly increased and in an unexpected manner. Also it soon became apparent that while the storage was sufficient if the rains were distributed over the year, and in average quantity of rainfall, yet there were periods of drought when the storage must be increased in order to ensure, under reasonable conditions, a full supply under any weather conditions.

Moreover, industries began to develop and to demand water. Thus, when a paper mill was built, the promoters required so much water for the works that they applied for, and obtained sanction, from the Government, to build a fairly large reservoir for water storage for that industry. Similarly, when Messrs. Butterfield & Swire Ltd.—the Taikoo organization—decided to erect a sugar works, and later a dockyard and engineering works, at the North-East end of the island, they built their own reservoirs, which to-day store nearly 180 million gallons of water and are supplied from quite a large catchment area of land. But there were many other industrial undertakings that applied for supply from the Government distribution system.

General Arrangements

At first sight it might appear that all that was required to ensure a full supply was money and technical knowledge sufficient to build reservoirs, filter beds, and mains for carrying water from the reservoirs to the taps of the consumers. But great technical skill is essential for efficiency.

It must be explained that, in selecting a site for a reservoir, the water engineer seeks a position high enough above sea level for the water to fall by gravity to the mains to all points of the distribution area. There is friction through a long length of pipe and water will not flow sufficiently fast unless the level of reservoirs, etc., is sufficiently high above the places where it is to be used.

It is obvious that if a reservoir is situated at, say a level of 200 feet above the sea, then the whole of the land below that level is useless as a catchment area.

On the other hand, if the reservoir is placed at, say sea-level, then a great deal of fuel must be used to pump the water to a height sufficient to give it the velocity, essential for proper distribution.

Therefore, you will find that the first reservoirs to be built in Hongkong are all well above sea level, and require no machinery for pumping. Gravity supplies sufficient force to send the water through all the pipes.

Later it was decided to utilize certain lower levels as catchment areas. And that meant the provision of pumping machinery. And, of course, when houses began to be built on the Peak, well above the level of the older reservoirs, pumps had to be used to force the water to those higher levels.

Fortunately, up-to-date, pumps have been unnecessary on the mainland. The New Territories provide large catchment areas high above the sea level. Reservoirs can be built at heights 400 or 500 feet above the sea.

But it is worth noting that rough plans have been sketched out showing the possibility of providing much greater storage on the mainland at lower levels than are being considered for immediate extensions. The enormous increase in the demand for water during the last fifty years in Hongkong has made the engineers far sighted enough to consider possibilities of a similar big increase in demand in future.

It seems, however, certain that the schemes now in hand will provide sufficient storage for many years to come.

Distribution Problems

There is not only the design of reservoirs, there are the problems of building channels to carry the water from catchment

areas into the reservoirs, arrangements for filtration and the many complications of distribution to houses and to places where connections can be made for fire. And not only the design, but the construction and maintenance of all that work. And then the revenue problem. An entirely free supply, even if practicable, results in great waste of water. And high prices lead to such economy of water as to endanger public health.

Sources of Supply

Some towns are fortunate, being within reasonable distance of some suitable source of supply, such as a lake or an uncontaminated river, which renders storage unnecessary.

But in Hongkong there were, in the early days, no such sources. And even now the Shing Mun river source of supply runs so dry during certain seasons that storage for water from that source is essential.

The usual practice seems to be to make reservoirs of a capacity equal to from 150 to 200 days' supply. But in Hongkong the provision planned is greater. Experience has taught them to be prepared for those cycles of three dry consecutive years.

There is some loss from the surface of the water in a reservoir by evaporation. It varies with the climate and surface area, and even with the wind crossing the surface. Fortunately it is least when the water level is lowest. And there is always some leakage in the reservoirs, pipes, etc., of any system.

Waterworks may be classified as gravitation works and pumping works. Gravitation works to be complete must consist of (1) either a high level impounding reservoir, or a high level intake with a settling reservoir (2) filter beds (3) a service reservoir (4) a distribution system.

A pumping system demands a low-level intake, and one or more settling reservoirs, filter beds, a pumping station, a high level reservoir to compensate for inequality of demand in 24 hours, and a distribution system.

The best site for a reservoir is where a valley widens out into a flat bottom bounded by steep sides the sides coming close together, as in a gorge, forming a contraction just below the flat bed. For the mostly costly part of a big reservoir is the dam and the shorter the length of the dam the better.

Earthen dams are cheapest, but water is apt to penetrate them. Johnstown, U.S.A. was destroyed (1890) by the bursting of an earthen dam, due to water perculation, etc., in the valley above it.

Masonry dams are superior to earth, but are not suitable for soft foundations. The problem of expense affects the choice—there may not be suitable stone in the vicinity.

Steel dams have been used in the United States, but steel must be protected from corrosion by pantry every two or three years.

Ferro-concrete dams can, and have been built in some parts of the world, at a cost lower per cubic foot than would have been possible with masonry.

In future contributions all of these matters, as they have affected the water problem in Hongkong, will be discussed. There will be full descriptions of the works now in hand and all of those completed. And it may ease the minds of some readers, resident or likely to be resident, in Hongkong, to know that such great progress is being made with new works, and such great efficiency in maintenance can be depended upon under the existing system, that soon there will be no more inconvenience on account of a restricted supply of the fluid so essential for maintenance of health under our modern conditions of life.

The ranges of hills in the New Territory provide ample catchment area for the water supply of a city of more than a million. The Shing Mun river has never gone dry (Fig. 12); in the worst period of drought (1929) it supplied at least one million gallons a day to Kowloon. The Shing Mun catchment now helps to provide, not only water for Kowloon, but aids Hongkong (Fig. 13); the new Shing Mun Reservoir and existing reservoirs will, when completed, render possible a continuous supply on the island for some years. What is known as the first section of the Shing Mun Valley scheme was virtually completed in 1931, since when it has been possible to supply Hongkong island with water from Shing Mun by means of a 12-in. submarine pipe laid from Kowloon point to the island.

It has only been possible to give a general outline of the problems connected with the water supply of Hongkong in this article. The next contribution on this subject will deal with the supply obtained from the island of Hongkong. The details of the plans for Kowloon, Shing Mun, etc., will be given later.

It is hoped that some of the information given above will be found useful to those concerned with the new schemes for providing pure water to cities in China.

[This is the first of a series of informative articles on the Hongkong water supply by Prof. C. A. Middleton Smith which will appear in the *Far Eastern Review*.]

To Dredge Yangtze Bar

The difficult problem of how to remove 40,000,000 tons of mud from the Bar of the Yangtze River and lower its crest by about nine feet over a width adequate to admit large ships has been solved in Shanghai by the Whangpoo Conservancy Board with the construction of a special dredger in Germany at a cost of approximately $2,350,000. The actual dredging of the bar is expected to start early next year, when the giant dredger is scheduled to be brought to Shanghai.

The construction of this particular type of dredger is the result of years of study by the Whangpoo Conservancy Board, the deepening of the channel having been advocated about 60 years ago. As the result of a series of investigations, Dr. Herbert Chatley, engineer-in-chief of the board, has made a report on the subject, and this finally has been adopted by the Chinese Government. The special dredger, when completed will be able to remove and discharge 30,000 tons of mud in 10 hours.

Dr. Chatley stated that for the last 14 years the Whangpoo Conservancy Board had had under consideration the dredging of the bar of the Yangtze which forms the principal obstacle to the approach of deep draught ships visiting Shanghai. As far back as 1876 a former engineer-in-chief of the Board, Mr. Derijke, called attention to the necessity of improving the bar but until 1915 no new studies were made. At that time, in conjunction with the Chinese Maritime Customs, special investigations were made and in 1920 Dr. Chatley prepared a report for Mr. Von Heidenstam on the possibilities of dredging the Bar with the drag suction type of dredger. This report was adopted subsequently by the International Commission of Consulting Engineers for Shanghai Harbor Investigation in 1921, and the Government was advised accordingly. With the assistance of Mr. T. L. Soong, chairman of the board, approval was obtained from the Executive Yuan in 1930, authorizing the Whangpoo Conservancy Board to do the work.

In 1931 tenders were called for the first dredger. Owing to various causes, economic and political, no decision was then taken and in 1933, the 16 firms which tendered were invited to revise their offers. In July, 1933, 10 firms made revised offers and these firms included almost all those having special experience in building this particular type of dredger, which is quite different in its operation from ordinary river dredgers. The most favorable offer, combined with large experience of this particular type, was that of the German firm of Schichau.

The drag suction type of dredger is the result of an invention made about 1903 by an engineer named Fruehling. Its peculiar features is that it is not anchored but travels under its own power at a speed of about two knots and scrapes its suction pipe along the bed of the river, thereby forcing the mud into the pipe. A powerful pump draws mud mixed with water up the pipe and delivers it into special containers from which it may be afterwards discharged through doors in the bottom, or by pumping.

The dredger which is in the course of construction is one of the largest that has ever been built and will appear to external view just like a cargo ship. She will be 360 feet long, 60 feet wide, and when loaded with 4,000 tons of mud, will draw 18 feet. The guaranteed output of the dredger, including the discharge of mud two miles away from the dredging place is 25,000 cubic yards per day or over 30,000 tons in 10 hours. The contract price is £151,800. The general design and specifications have been prepared by Dr. Chatley, assisted by the dredging department of the board. The details of the design were made by Mr. Kolkmann, the chief technical of Messrs. Schichau.

Mr. William Smith, the board's dredging engineer, has been sent to Germany to collaborate with Lloyd's Surveyor in supervision of the construction. Mr. Smith was accompanied by two Chinese junior mechanical engineers. It is expected that the dredger will arrive in Shanghai early next year. In view of the tremendous task involved, the question is being considered by the board as to whether or not two dredgers of this kind will be required.

The New Works of the Shanghai Gas Co.

By W. J. BAKER, M.Inst.GasE., A.M.I.Chem.E., Engineer-in-Chief and Manager of the Shanghai Gas Co., Ltd.

(The following is supplementary to an article by Walter T. Dunn, M.I.Mech.E., which appeared in the June number of The Far Eastern Review.)

On February 26, 1862, the *North-China Daily News* of Shanghai published the prospectus of a proposed Gas Company to operate in the Foreign Settlement in Shanghai with a capital of Taels 100,000 in shares of Taels 100 each.

The Works were to be constructed for the lighting of 10 miles of streets with 500 street lamps, 100 foreign homes with 20 lights per house and 1,500 miscellaneous lights.

During December, 1863, $8\frac{3}{4}$ mow of land was purchased situated on Soochow and Defense Creeks and gas was eventually available for lighting purposes on November 1, 1865. The price charged at that time was $4.50 per 1,000 cubic feet, the number of consumers was 58, and the total length of gas main was five miles.

At the end of 1933 the price of gas was $2.85 per 1,000 cubic feet, the number of consumers 13,384 and the length of gas mains 194 miles.

During the year 1930 it was realized that the manufacturing plant existing at that time was inefficient and approaching the end of a useful life, the greater proportion of it having been installed about 1900, not only so, but the yearly consumption of gas had increased rapidly and steadily since 1925 and further gas manufacturing plant was essential.

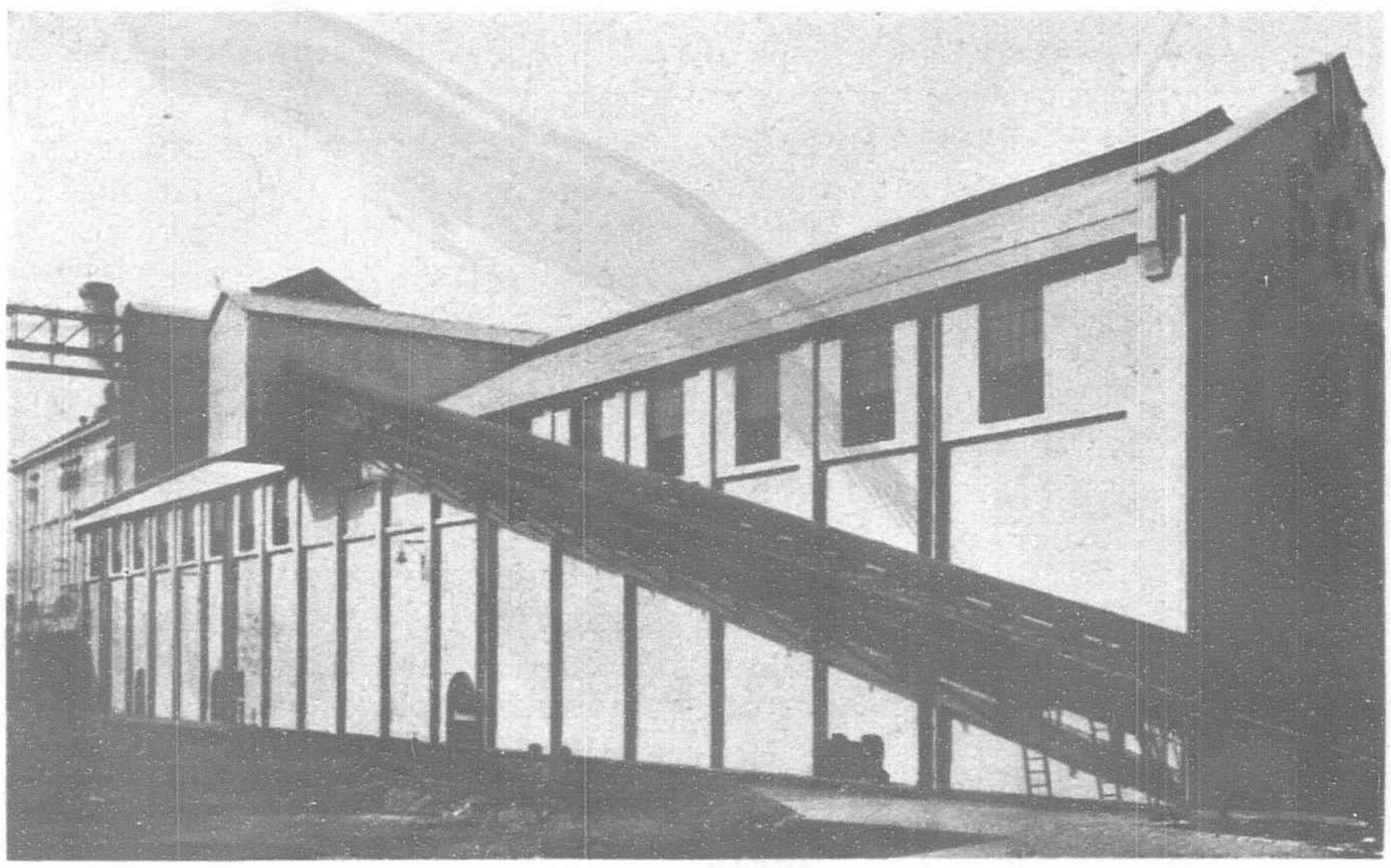
Eventually it was found that to instal new modern plant on the Thibet Road site, whilst still maintaining the supply of gas to the city, would be an extremely expensive proposition, by reason of the awkward position of the available vacant area of land on the existing site.

During 1931, schemes were prepared for the erection of a new plant to produce four million cubic feet of gas per diem, and to embody all the most modern improvements in gas manufacture and purification, and designed to allow for extensions to produce 10 million cubic feet per diem.

The new site, 32 mow in area, measuring approximately 160 feet wide by 1,425 feet long, was purchased in August 1931, and the construction of bunding, wharf and boundary wall was commenced towards the end of that year and the site was drained and filled. The foundations for the Retort House and Gasholder were constructed during the Summer of 1932 and erection of the first portion of plant was commecned on November 20, 1932. The complete installation was ready for gas making on February 6, 1934, the whole works thus taking $14\frac{1}{2}$ months to construct. The plant was put into operation and gas made on February 8, 1934: the old Thibet Road plant was shut down on March 13 and demolition commenced.

The new plant is designed to make and purify gas, which is pumped from the new Yangtszepoo Works to the gas holders in Thibet Road, from where it is distributed to the city, consequently the gas holders, office and distribution workshops remain at Thibet Road.

The new plant has been designed to reduce native labor to a minimum consonant with financial expenditure, and comprises the most up-to-date plant for the manufacture and purification of gas.



Exterior view of the Road Store of the New Works

Coal Handling Plant

A block plan of Works is shown in Figure I. Coal is unloaded from 200 ton lighters by a six ton Clarke Chapman Steam Crane and fed through an "Avery" Automatic Weighing Machine on to No. 1 inclined band conveyor, from thence on to No. 2 cross band conveyor which delivers onto a shuttle band conveyor No. 3, feeding either into the store on or to the bridge conveyor No. 4. The arrangement of No. 3 and No. 4 conveyors which can both travel the length of the Coal Store, enables the store to be filled so that the surface of the stored coal is quite flat and the fullest advantage is taken of the covered-in area. The thought will undoubtedly occur "Why have such an elaborate system of handling coal and why a closed-in coal store? Our reasons for the arrangement adopted are:—

The saving on the stevedore's cost for unloading coal is $0.32 per ton which, on the quantity now handled, amounts to $16,000 per year.

The reduction in labor operating inside the coal stores has been reduced by $3,580 per year, resulting in a direct reduction in labor cost of $19,580 per year. Against this item must be debited the cost of power for operating the plant, assessed at $1,575 per year.

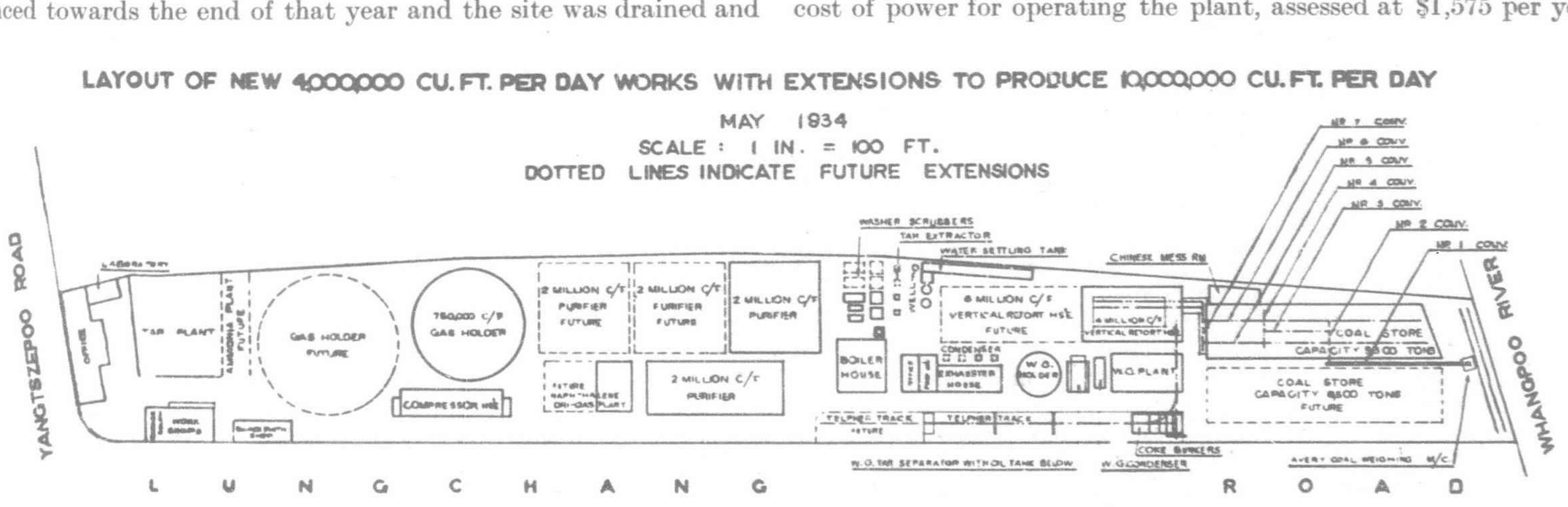
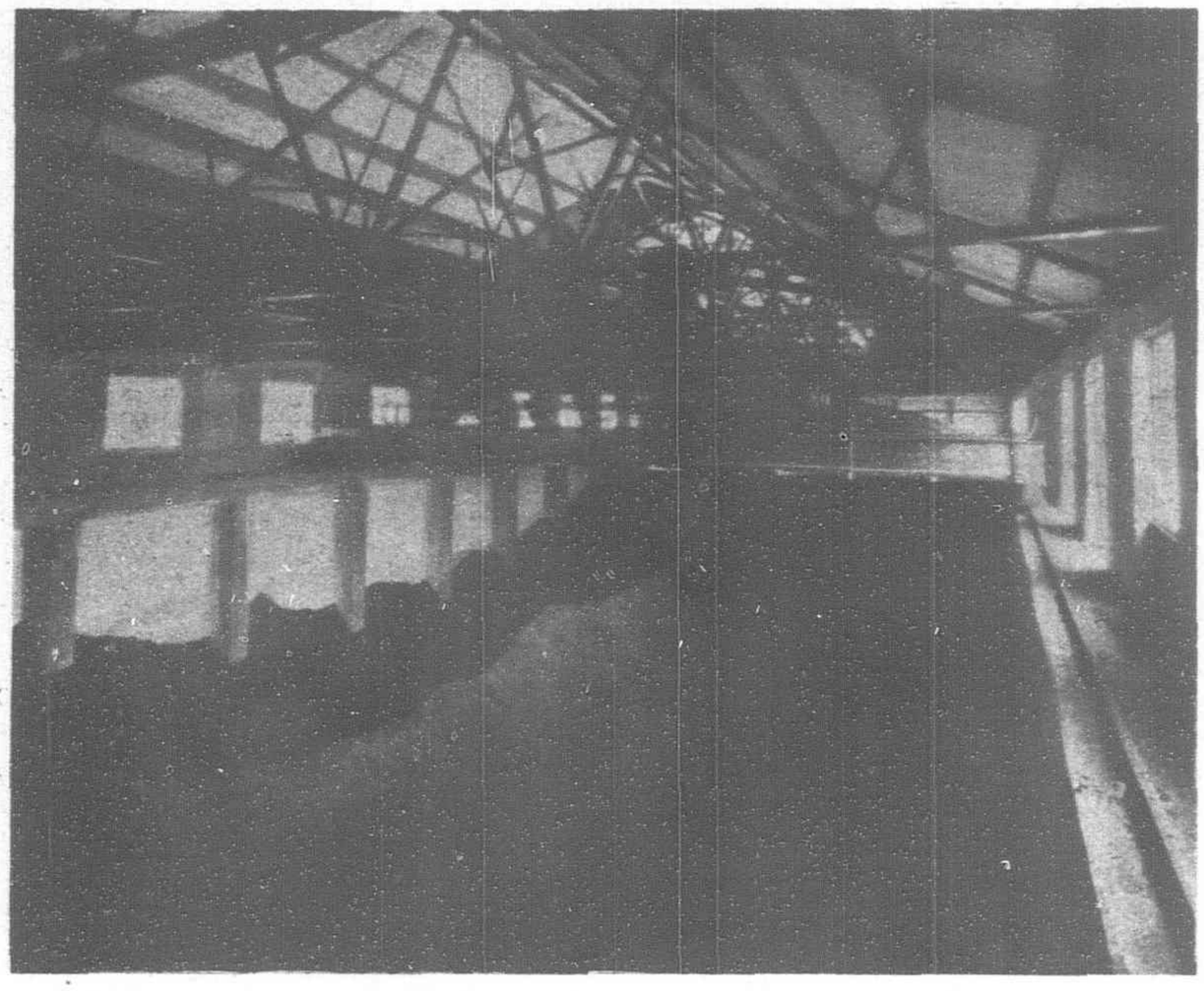


Fig.—1



Interior view of the Coal Store

Showing conveyors above Retort House Coal Hoppers

The cost of the complete Coal Handling Plant, not including the R/C Coal Store was $131,445, which sum capitalized at 12½ per cent amounts to a yearly expenditure of $16,430.62.

Summarizing the above items we have :—

Reduction in cost of labor	$19,580	per year
Less Cost of Power	1,575	,,
Saving on Total Expenditure	$18,005	per year

which is $1,574.38 per year greater than the capitalized cost of the plant.

With regard to the closed-in store : The angle of repose of coal is approximately 45° and to store 5,500 tons in the open would require ground area greater than the present coal store area by 0.65, which represents a capital outlay of $29,500. The cost of the reinforced concrete coal store was $35,000.

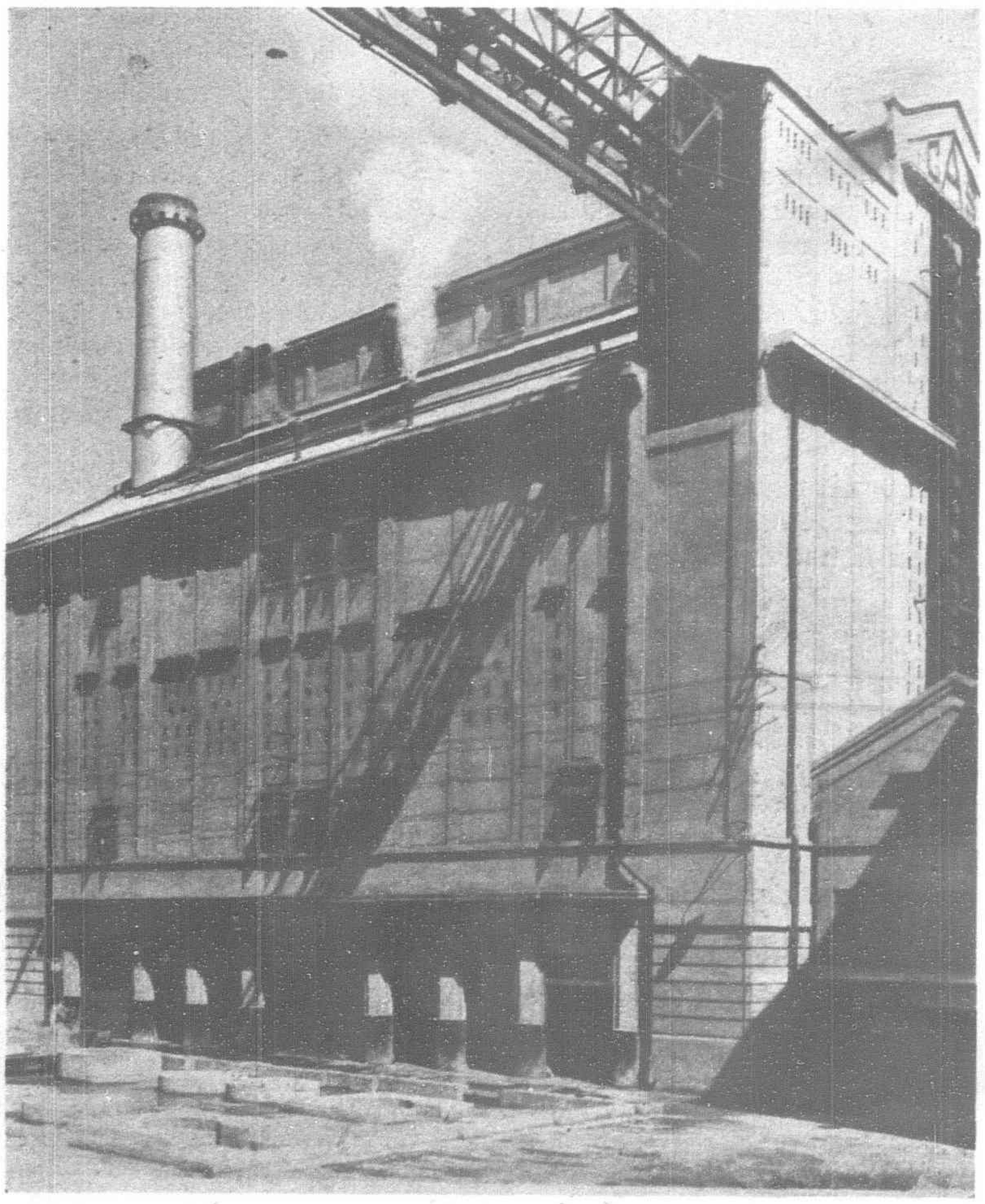
The closed-in store was considered advisable because of the greater facilities offered for the mechanical handling of coal into and out from the store and because bituminous coal used in Shanghai for the manufacture of coal gas rapidly decreases in volatile content when stored in the open.

Coal is taken from the store on two underground band conveyors No. 5 and No. 6 travelling the long way of the store and feeds on to a Cross Band Conveyor, No. 7, at the north end of the store.

Conveyor No. 7 feeds the coal into the boot of a bucket elevator, which elevates the coal to a height to allow it to gravitate through an overhead coal breaker and an "Avery" Automatic Weighing Machine and thence to the filling chamber of the gravity lip bucket conveyors.

The bucket elevator limits the depth of the filler pit to 13 feet : without the elevator the depth would have been 23 feet.

The gravity lip bucket conveyors encircle the entire retort bench. They travel in trenches beneath the retort house floor, up the north end of the bench, above the overhead coal and coke bunkers and down the south end of the retort house. Not only is coal elevated to the coal bunkers in the lip bucket conveyors, but coke discharged from the bottom of the vertical retorts is also fed into them and transported to the overhead coke bunkers for supply to the producers.



Exterior view of the Retort House

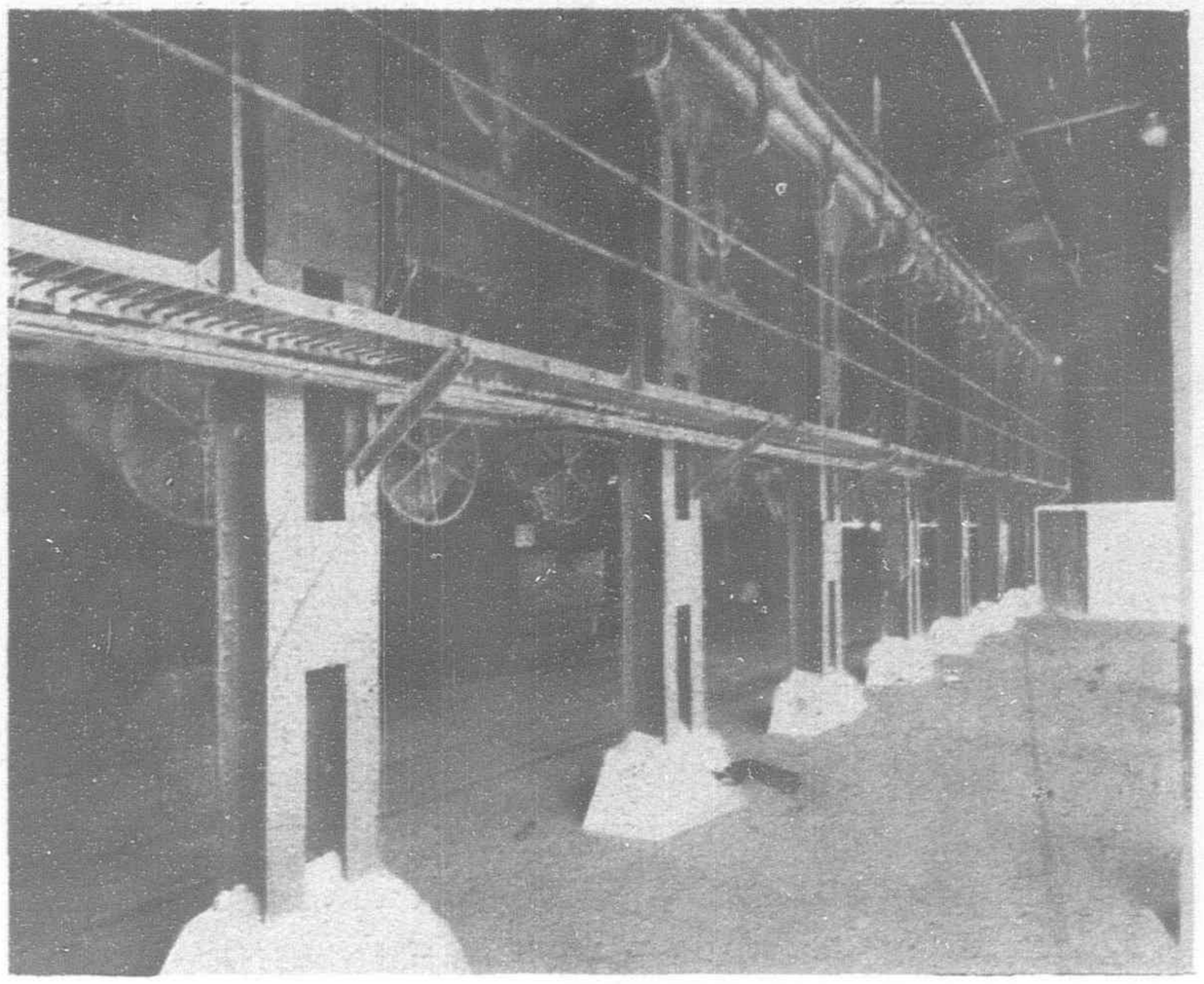
Carbonizing Plant

This plant supplied by Messrs. Woodall-Duckham Vertical Retort and Oven Construction Co., Ltd., consists of one bench of 30—80 inch major axis upwardly heated continuous vertical retorts capable of producing four million cu. ft. of gas per day from coal. Coal is fed from the overhead bunkers through a valve into an auxiliary hopper—it then gravitates down through the retort : the speed of the gravitation being controlled by a mechanical extracting device at the bottom of the retort.

The retorts are surrounded by a system of heating flues, which obtain their heating gas from a battery of external coke fired producers. The maximum temperature required on the external walls of the retorts is 1,400°C, which is developed on the two stage combustion principal by the addition of a supply of secondary air to combust the producer gases in the combustion chambers. A special feature of the plant is the large capacity of the producers which have been designed to utilize Breeze, thereby releasing the maximum quantity of coke available for sale.

Inside the retort house are two waste heat boilers, each large enough to receive the waste producer gases after they have accomplished their work of heating the 30 retorts. The amount of steam which can be raised at 120 lbs. per sq. inch pressure with all retorts in operation is about 14,500 lbs.

Gas offtake and view of Auxiliary Coal Hoppers and Retort House



Showing equipment of Retort House

per hour. During the operation of the retorts, the charge of coal at the base of each retort has been carbonized to coke. Steam is injected on to this mass of coke, and cracking occurs producing carbon monoxide, carbon dioxide and hydrogen. These gases pass up through the charge of coal in the retort, and mix with the coal gas produced higher up. The combined gases leaving the retort pass through a system of pipes and on to water tube condensers.

Coke Handling Plant

Coke and breeze not required for the producers is discharged from the retorts into skips which are pushed to the south end of the house where a three ton telpher picks up the skips and transports them along the overhead track depositing the coke either in the yard storage space or into a hopper feeding a system of screens above the reinforced concrete storage hoppers.

Chutes at the base of the hoppers discharge the graded coke into lorries or baskets.

The screens grade the coke into four sizes :—

Up to $\frac{3}{4}$ inch.
$\frac{3}{4}$ inch to $1\frac{1}{4}$ inches.
$1\frac{1}{4}$ inches to two inches.
above two inches.

An "Avery" Automatic Weighing Machine is built into the overhead telpher track and records the weight of the coke contained in the skip.

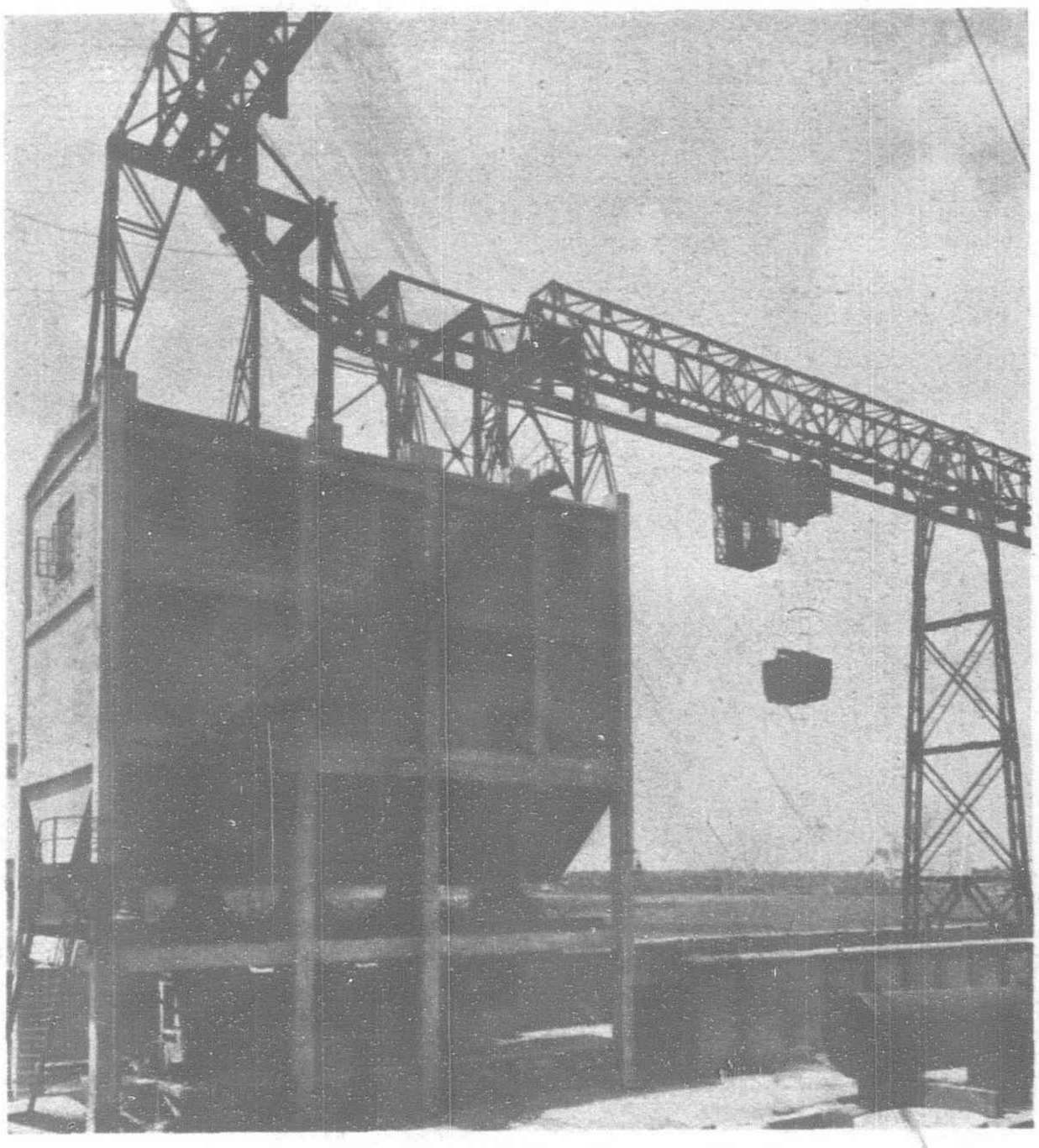
Cooling

The gas leaving the retort house is approximately 160°F, and is a thick heavy yellow-colored gas. It contains quantities of impurities, the chief of which are tar, ammonia, sulphuretted hydrogen, naphthalene and moisture.

The first operation is to cool the gas by passing it through water cooled tubular condensers. Water passes through the tubes and each condenser contains 477 tubes. The temperature of the gas is reduced to approximately 60°F, resulting in the elimination of a large portion of tar and ammoniacal liquor which condenses out and is drained away to storage tanks. Gas cooling is often accomplished by atmospheric condensers, but the water cooled type are cheaper, provided an ample supply of cheap water is available: The ground area required is about 1/20th. of that required for the atmospheric type.

From the outlet of the condensers, the gas passes to a steam driven exhauster. This unit is equivalent to a 3-blade slow speed fan, and might be called the "Heart" of a gas making plant. It draws the gas from the carbonizing plant, through the condensers and pushes it onwards through the other purification plant and into the gas holders.

Should the "Exhauster" ever fail and cease to function, the pressure of the gas increases in the pipe line at the outlet of the retorts, and automatically brings into action and releases a governor, whereby all gas being made is blown away into the atmosphere. Such is not a very desirable state of affairs, and the exhauster usually receives more attention than any other portion of the mechanical plant.



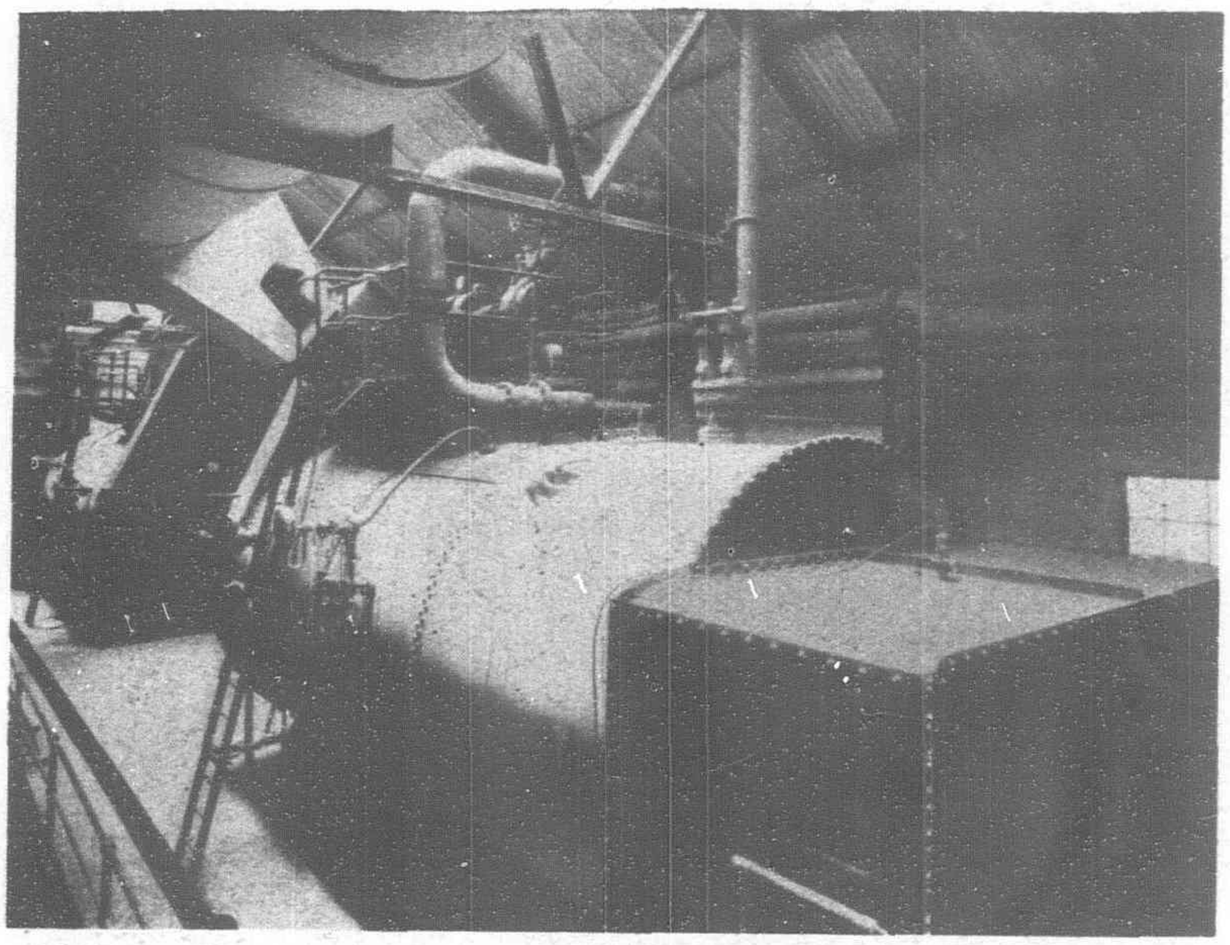
Telpher track and Coke Storage Bunkers

Wet Purification

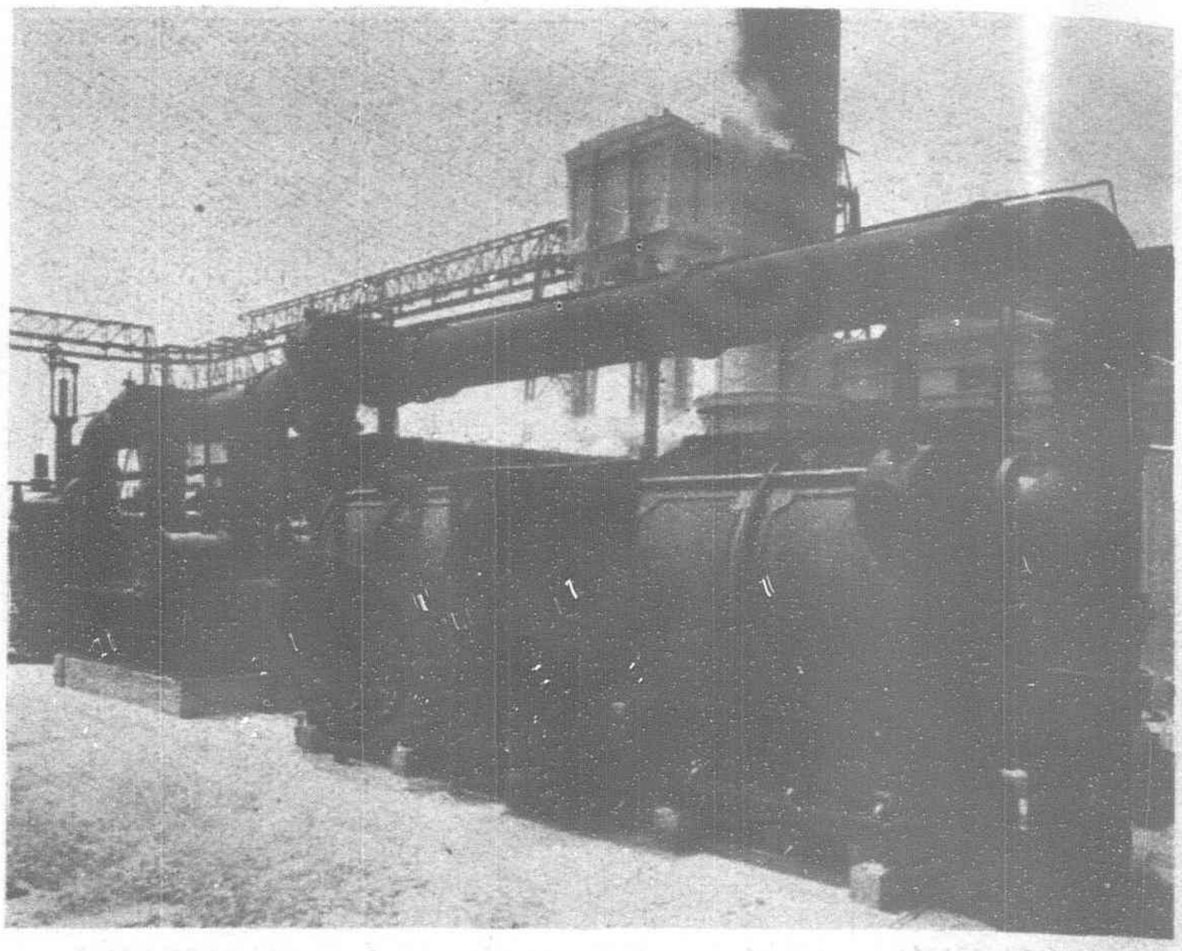
The principle underlying all systems of wet purification of coal gas is to subject the gas to as much disturbance and friction as possible and to expose it in minute flows to as great a wet surface as possible.

From the exhauster, the gas is divided into two streams and pushed through Pelouze and Audouin tar extractors, which eliminate all thick tar and the majority of the tar fog.

Each tar extractor consists of perforated vertical cylinders, contained in a cast iron casing. The cylinders are sealed in water and the only exit for the gas is through the perforated cylinders. The center cylinder is attached to an arm and rod, which is balanced by weights on the outside, and the pressure of the gas on this center cylinder, together with the oscillation due to the beat of the "Exhauster" causes the cylinder to oscillate, thereby creating a disturbance of the water seal and sufficient friction to bring down the heavy tar and tar fog.



Showing waste Heat Boilers



Showing waste scrubbers, Livesay washer and tar extractor

Passing through the tar extractors, the gas continues in two streams, and enters the "Livesay Washers," where it is forced through horizontal layers of perforated pear-shaped tubes, sealed in ammoniacal liquor. Here again, the gas is subject to great friction and is split up into minute streams, which results in the removal of light tar fog, and a large proportion of the ammonia.

The next and final wet purification units are "The Rotary Washer Scrubbers," which consist of brushes or chequered board attached to the perimeter of cylinders, keyed on to a horizontal steam driven shaft. The cylinders are contained in a cast iron casing and are sealed in ammoniacal liquor. During the rotation of the cylinders, the gas passes through a system of ports and in minute streams is brought into contact with the large wet surface of the brushes or chequered boards.

The Rotary Washer Scrubbers are essentially for the elimination of the final traces of ammonia, and a plentiful supply of water or weak ammoniacal liquor takes up all the remaining ammonia in the gas and provides a large quantity of strong ammoniacal liquor which runs off into underground tanks—later to be worked up into saleable commodities.

Dry Purification

The next impurity to be eliminated is sulphuretted hydrogen, and this is accomplished by passing the gas through layers of oxide of iron, which absorbs the sulphuretted hydrogen forming Iron sulphide, expressed by the simple equation :—

$$Fe_2O_3 + 3\,H_2S \quad = \quad Fe_2S_3 + 3\,H_2O$$

After the iron oxide has been in use for some time, it becomes "foul," and unable to take up any further quantity of sulphuretted hydrogen, but by exposing the material in thin layers to the atmosphere, it is "revivified," and can be re-used.

The chemical action is expressed by :—

$$Fe_2S_3 + O_3 \quad = \quad Fe_2O_3 + S_3$$

This procedure may be performed three or four times until the material contains between 40 per cent and 50 per cent free sulphur, when it is known as "spent oxide" and in Europe is sold for the manufacture of sulphuric acid.

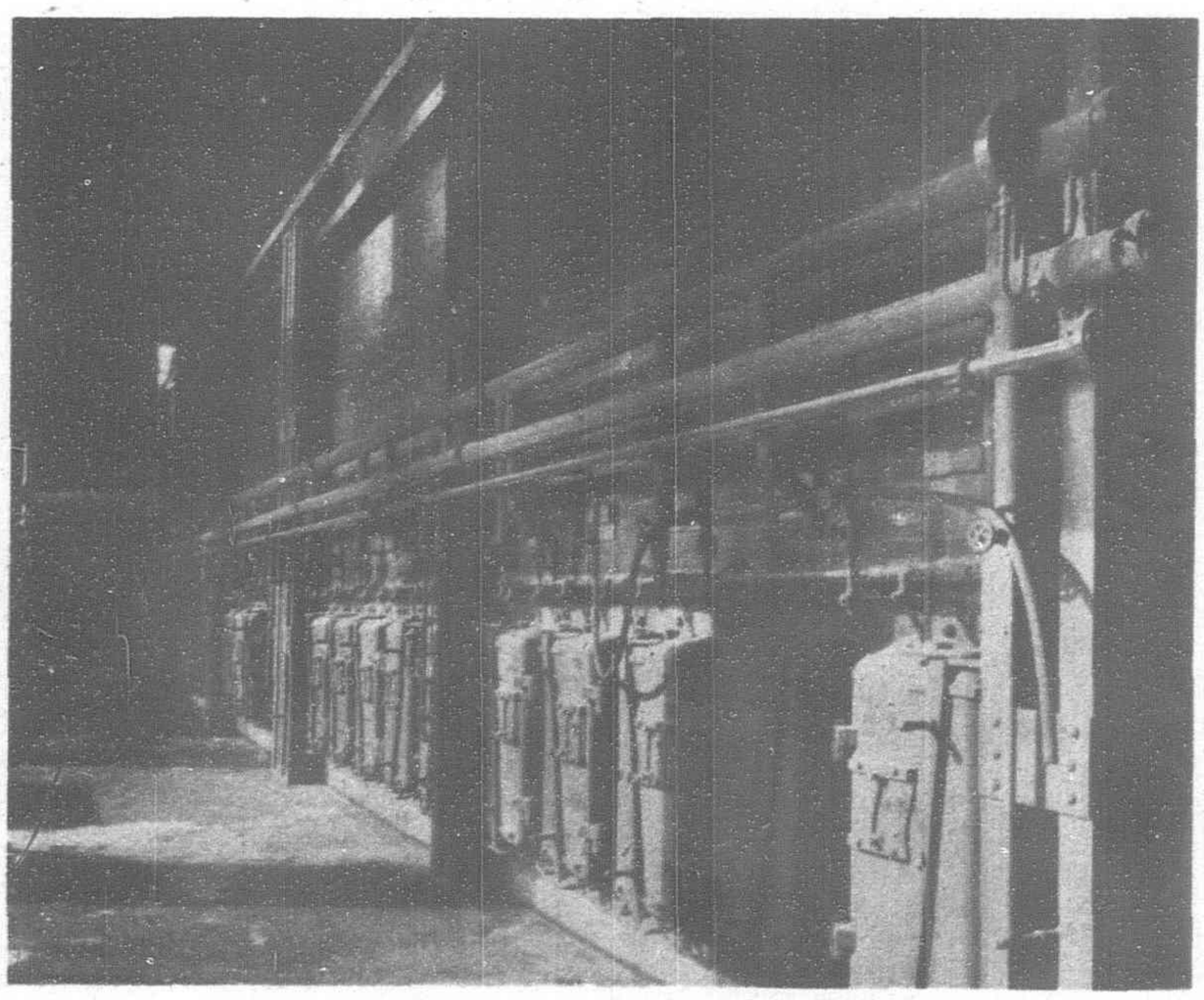
In Europe, oxide of iron is obtained in the form of natural bog ore from Ireland or Holland but in Shanghai we make the material from a mixture of iron borings and sawdust. The latter is used to make the final material lighter and finer.

There are two units of purifiers ; one has been transferred from the Thibet Road Works ; the other is new and made by Messrs. Newton Chambers & Co., Ltd. The design and construction of both units is identical.

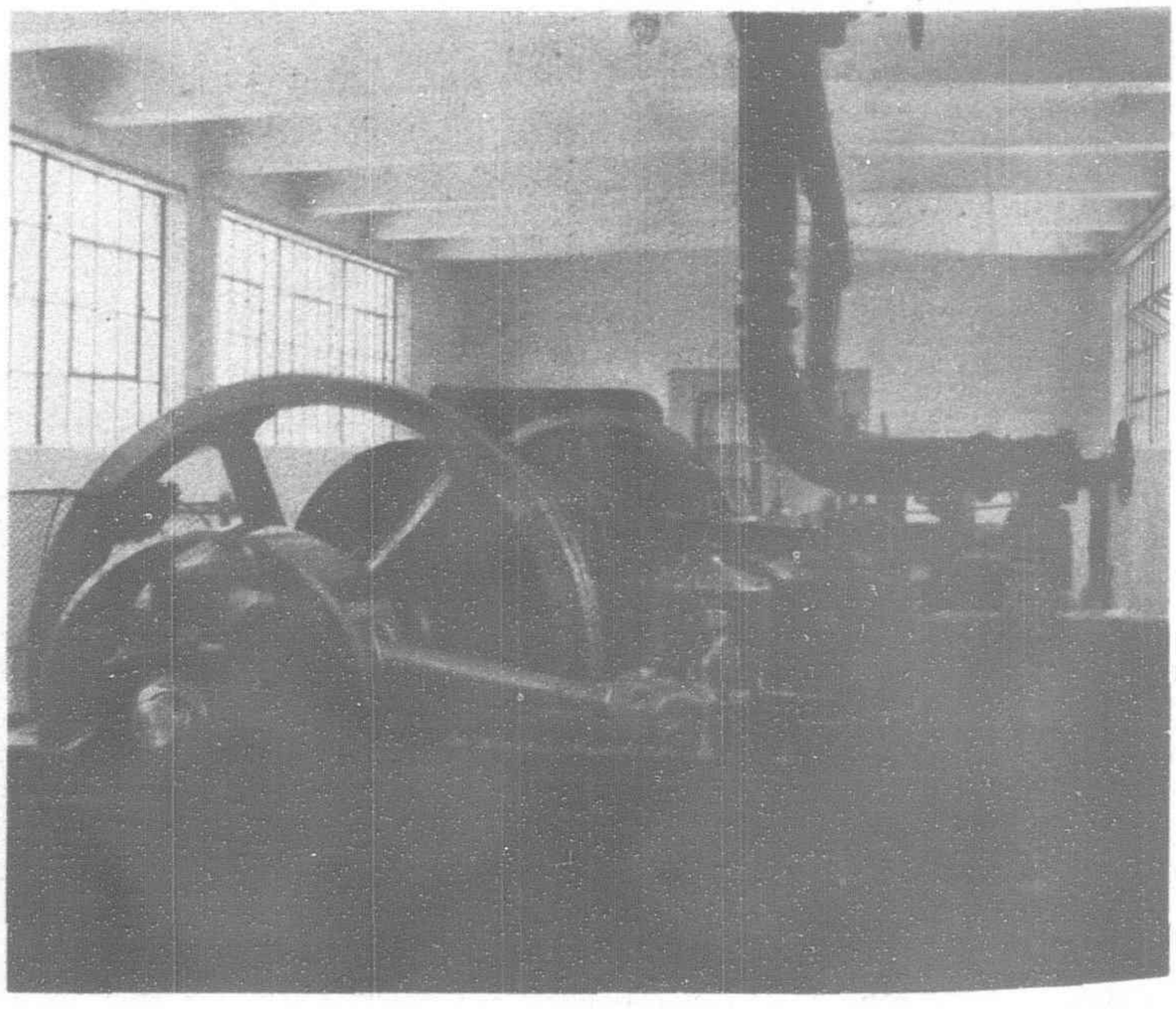
Describing the new purifiers :—

The oxide of iron is contained in four cast iron boxes, each 40 feet square, and seven feet deep, arranged in monoblock and supported on a Reinforced Concrete Structure with a R/C revivifying floor above the boxes and R/C tar and liquor storage tanks, having a total capacity of 400,000 gallons below ground.

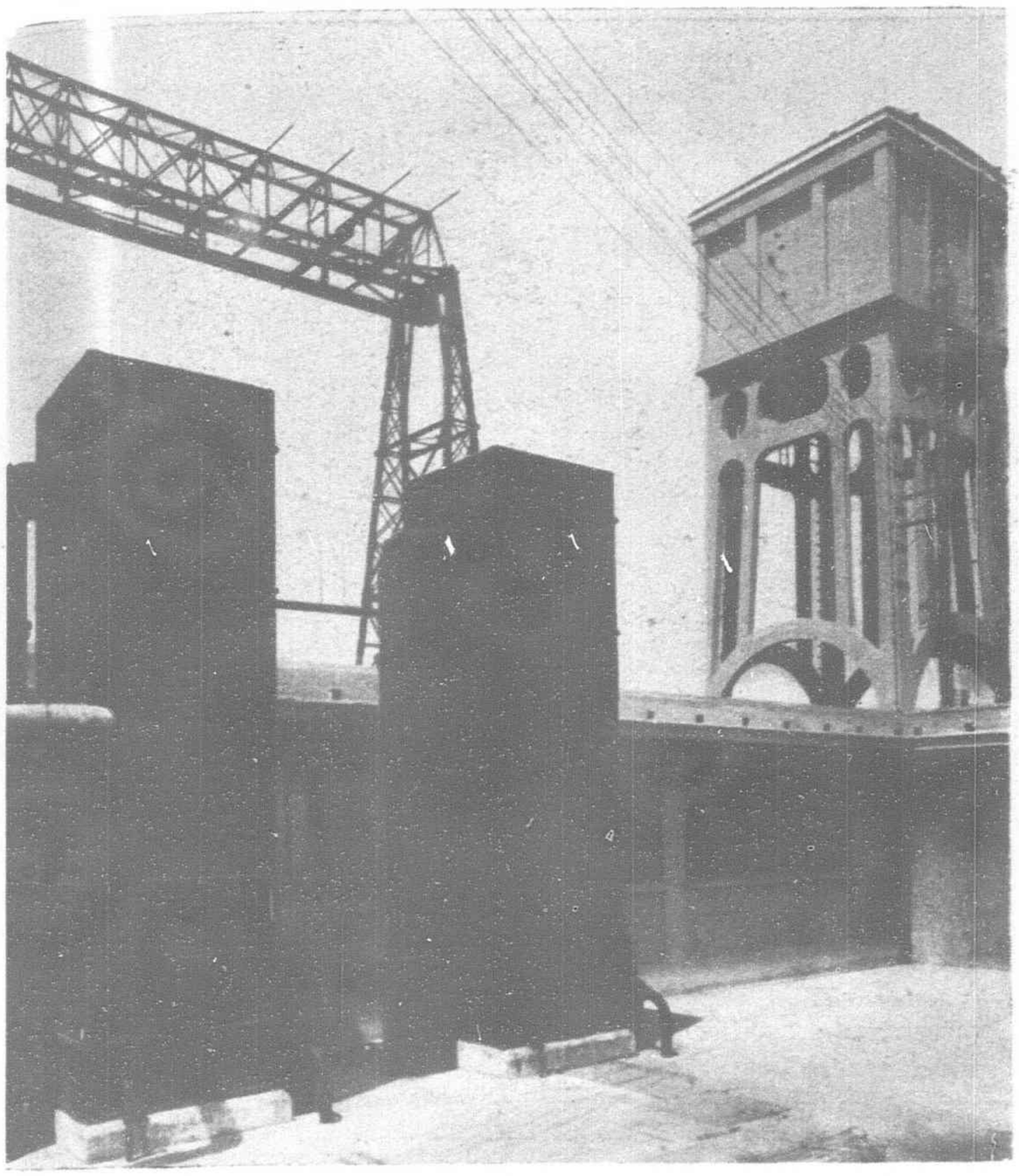
The purifiers are formed of cast iron plates, $\frac{3}{4}$ inch thick for bottom, sides, and divisions,with a cast iron balcony round each of the cover openings. Each purifier has four cover openings



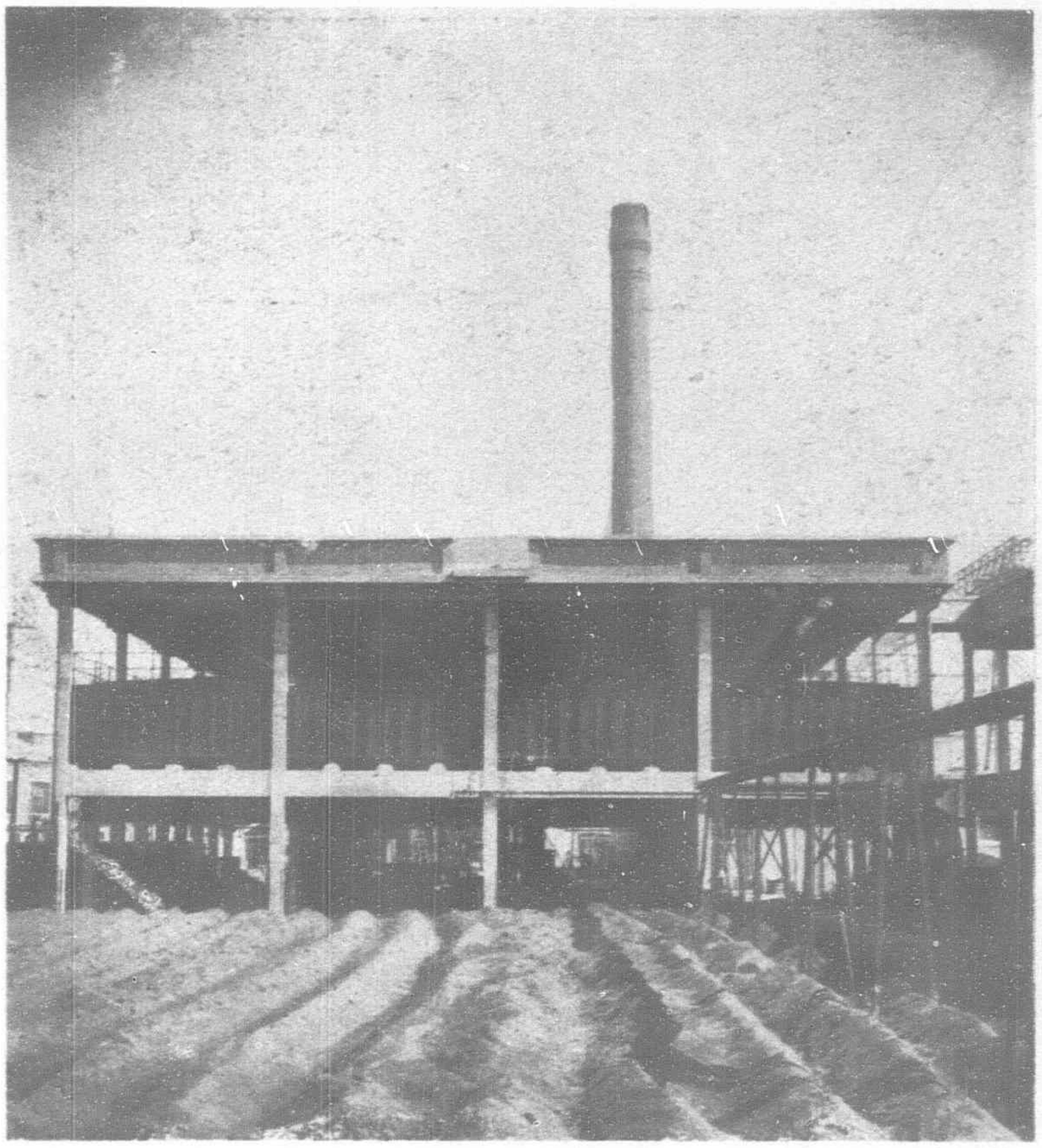
Showing Retort House producers



View of "Exhausters"



View of water tubed condensers and water supply storage tank



View of Purifiers

17 feet square, provided with mild steel covers. A machined lip is provided round each cover-opening, and the joint between the cover and the machined lip is made of swing-bolts fitted with ring-nuts. One cover in each box is provided with an air-plug and test-cock.

The covers are raised by means of hand-operating lifting-blocks, of which there are four, running on the lower flange of a joist, and secured to the underside of the re-vivifying floor, one runway-joist being fixed over each row of covers. The interior of the purifiers is arranged so that they may be fitted with five tiers of wood-grids, supported on ledges cast on the side and division-plates, and on cast iron standards. At the bottom of each purifier are four oxide-chutes, from which spent-oxide can be discharged on to the ground level.

At one end of the re-vivifying floor a short runway is provided fitted with a one ton electrically operated lifting-block, by means of which the oxide can be hoisted from the ground-level to the revivifying-floor in suitable skips.

The pipe connections are of mild steel, supported by slings from the underside of the purifier-supporting girders. Each purifier has one 24 inch gas inlet, and two 18 inch gas outlets, each provided with a valve which can be operated by means of a chain from the ground-level.

The oxide of iron is loaded on to the wooden grids mentioned above, each box containing about 140 tons of the material. The gas enters at the base of the boxes beneath the bottom layer of iron oxide, passing up through it and finding its exit above the top layer.

The boxes are operated in series and the flow of gas is changed round or diverted to enable any one box to be opened and its contents removed.

Dri-Gas and Naphthalene Extraction Plant

At the outlet of the two units of purifiers, the two streams of gas meet and go forward as one stream to the Dri-Gas and Naphthalene Extraction Plant, for the elimination of water vapor and naphthalene. It has to be borne in mind that service to the consumer demands not only that gas shall be of a composition suitable to the local requirements, and as free from impurities as possible, but that the supply shall be dependable. The ideal supply cannot be attained when the gas carries with it on the district elements which are liable to be deposited, either in liquid or in solid form, before the gas is available for consumption.

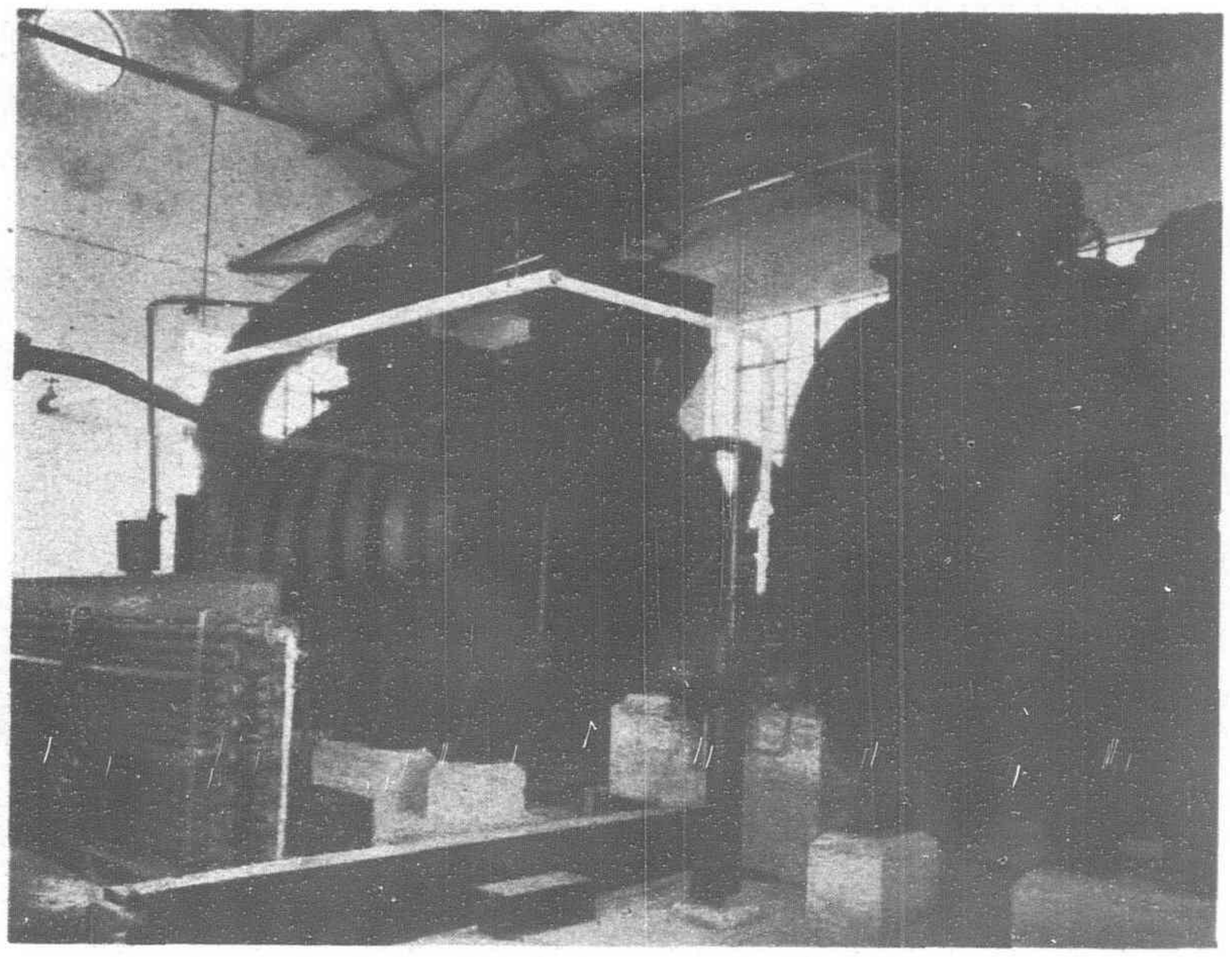
After crude gas leaves the retort, a considerable amount of work with respect to its purification is connected with the circumstance that water-vapor is present in the gas. It is, however, when the gas passes out of the works that the presence of water-vapor becomes a definite danger and a nuisance. In the distribution system the gas may be exposed to millions of square feet of iron and steel, which incidentally represent a large fraction of the capital of the undertaking. This exposure may last many hours, and a very thorough final cooling and condensation therefore takes place. There is thus every condition for the promotion of the process of corrosion. Aqueous condensate, containing weak acid and saline impurities, in the presence of traces of oxygen, will attack in time any grade of iron, and will break down most known protective covering.

Products of corrosion are much greater in volume than the metal from which they originate, and, moreover, are not necessarily spread out uniformly. They may aggregate. A result of such corrosion is therefore a reduction in the effective area of capacity of the pipes involved. Wrought-iron or steel pipes being thinner than those of cast iron generally, become eventually perforated, unless their choking up leads to their earlier renewal. The object of drying is to prevent the formation of aqueous condensate. Rusting of iron and steel requires primarily the presence of liquid water. This has been conclusively demonstrated by a good deal of independent investigation.

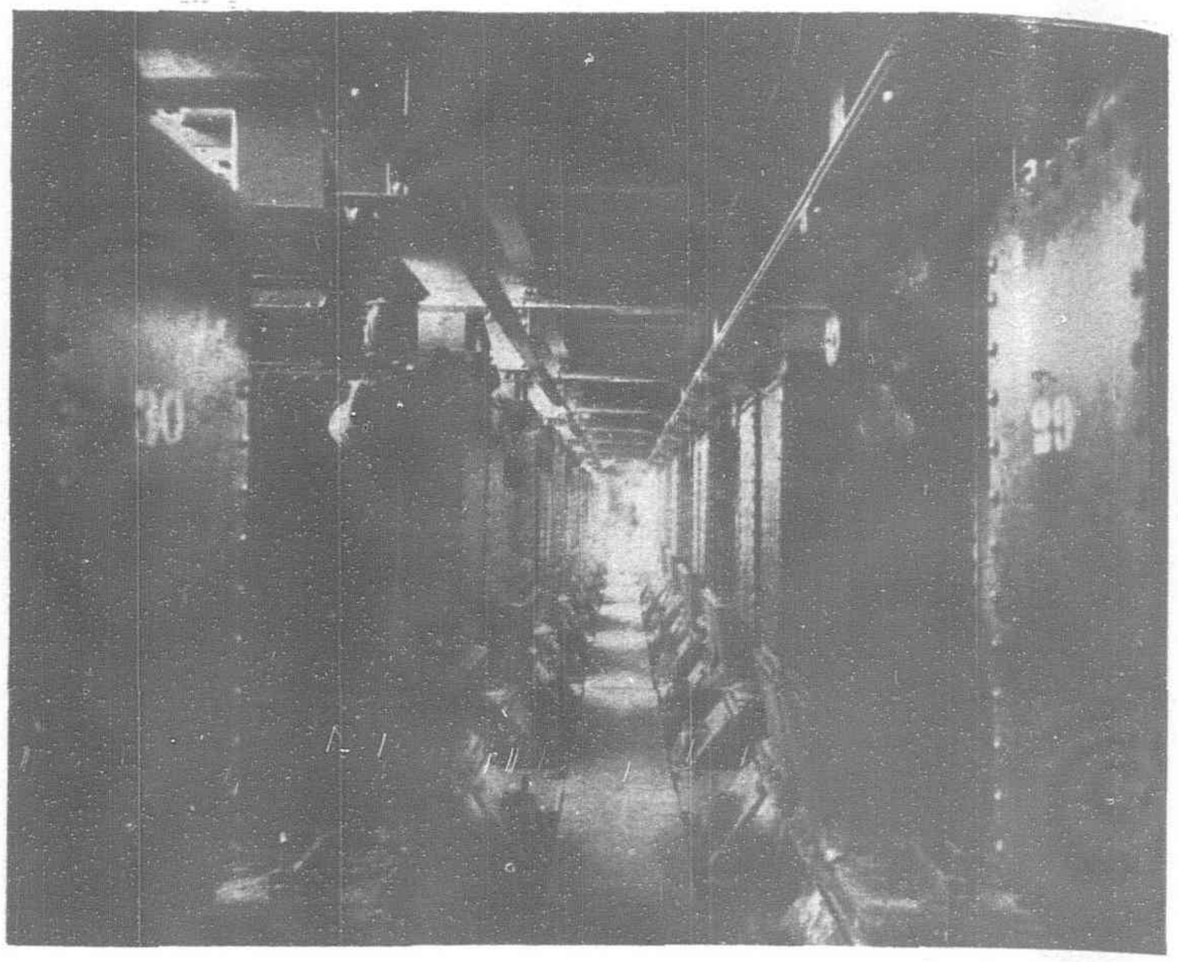
A main or service pipe which is kept dry will not collect rust deposits, and can be regarded as practically permanent. It will not, therefore, be subject to any reduction of effective area of gas-carrying capacity. It will always yield the maximum supply of gas to the consumer. A dry gas-meter which is free from water-deposits will have years longer life than one which is subject to the influence of water deposits. Aqueous solutions, due to water content, also act delecteriously on the leathers of the meters, tanning them to a point which destroys their flexibility.

Another important advantage of the dri-gas process is that the normal oily condensate from the gas, or an oil spray, if such be employed, will be many times more effective in a dry system of distribution, and will not proceed so quickly into syphons and thus be lost.

In the plant in question, gas is dehydrated by contact with an absorbent (calcium chloride) in the first unit of the washer, a constant circulation being maintained by means of pump driven by the washer engine. In passing through the washer the liquid is slightly



View of Dri-Gas and Naphthalene Plant



Charging floor of Retort House

diluted and warmed up by the absorption of the water, and, to secure reconcentration, a small quantity is continuously passed over an evaporator heated by the exhaust steam of the washer engine. In the second unit the naphthalene is absorbed by adding oil to the extent of 10 to 25 gallons per million cubic feet of gas per day. The whole plant, it may be added, is capable of control by unskilled labor, and the daily attention needed, including oiling and greasing, does not require mor than 45 minutes.

Station Meter

Leaving the Dri-Gas and Naphthalene Plant, the gas passes through the station meter, which is of the new "Holmes-Conversville" type, having a normal rated capacity of $3\frac{1}{2}$ million cu. ft. per day, with a maximum capacity of seven million cu. ft. per day. The meter is fitted with a counter showing the volume of gas passed in cubic feet, and differential pressure gauge to indicate the pressure loss across the meter.

A gauge also records the volume, temperature and pressure of the gas during its passag through the meter.

The Holmes-Conversville Meter consists of two 8-shaped impellers, rotating in a cast iron casing. It is purely the pressure of the gas which rotates the impellers. The meter is correct to within 1.0% and requires 25 sq. ft. ground space, compared with 506 sq. ft. required by the usual type of wet drum station meter.

Gas Holders

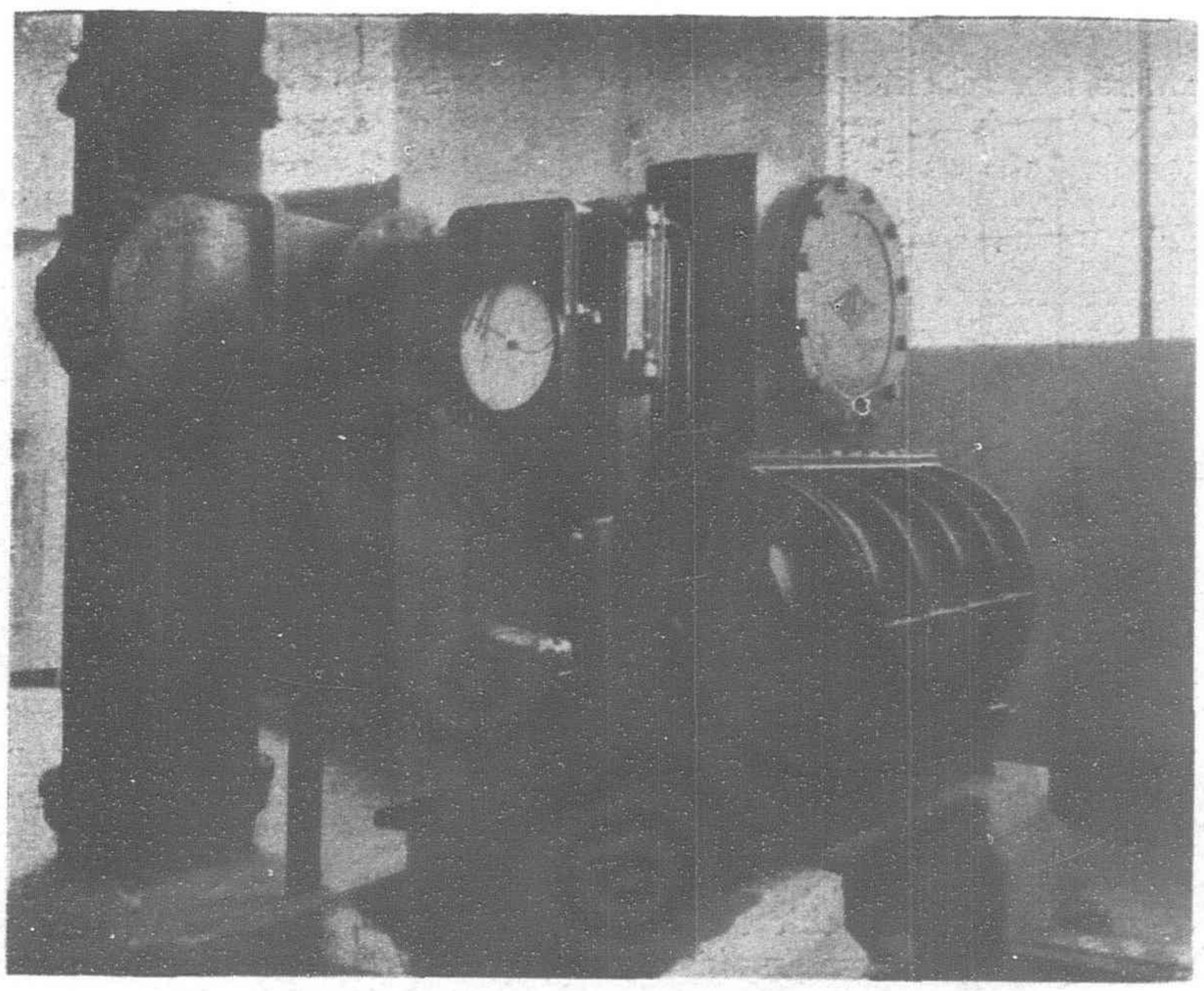
From the outlet of the meter, the gas passes into the gas holder, which has a capacity of $\frac{3}{4}$ million cu. ft., and was made by Messrs. Samuel Cutler & Sons, Ltd. It consists of three spirally guided lifts contained in a steel water tank, 112 feet in diameter, by 30 feet deep, and when fully inflated rises to a height of about 120 feet above ground level.

The design embodies every modern improvement for safety, correct working and durability. The entire construction comprises about 800 tons of British steel, manufactured at the London works of Messrs. Samuel Cutler & Sons.

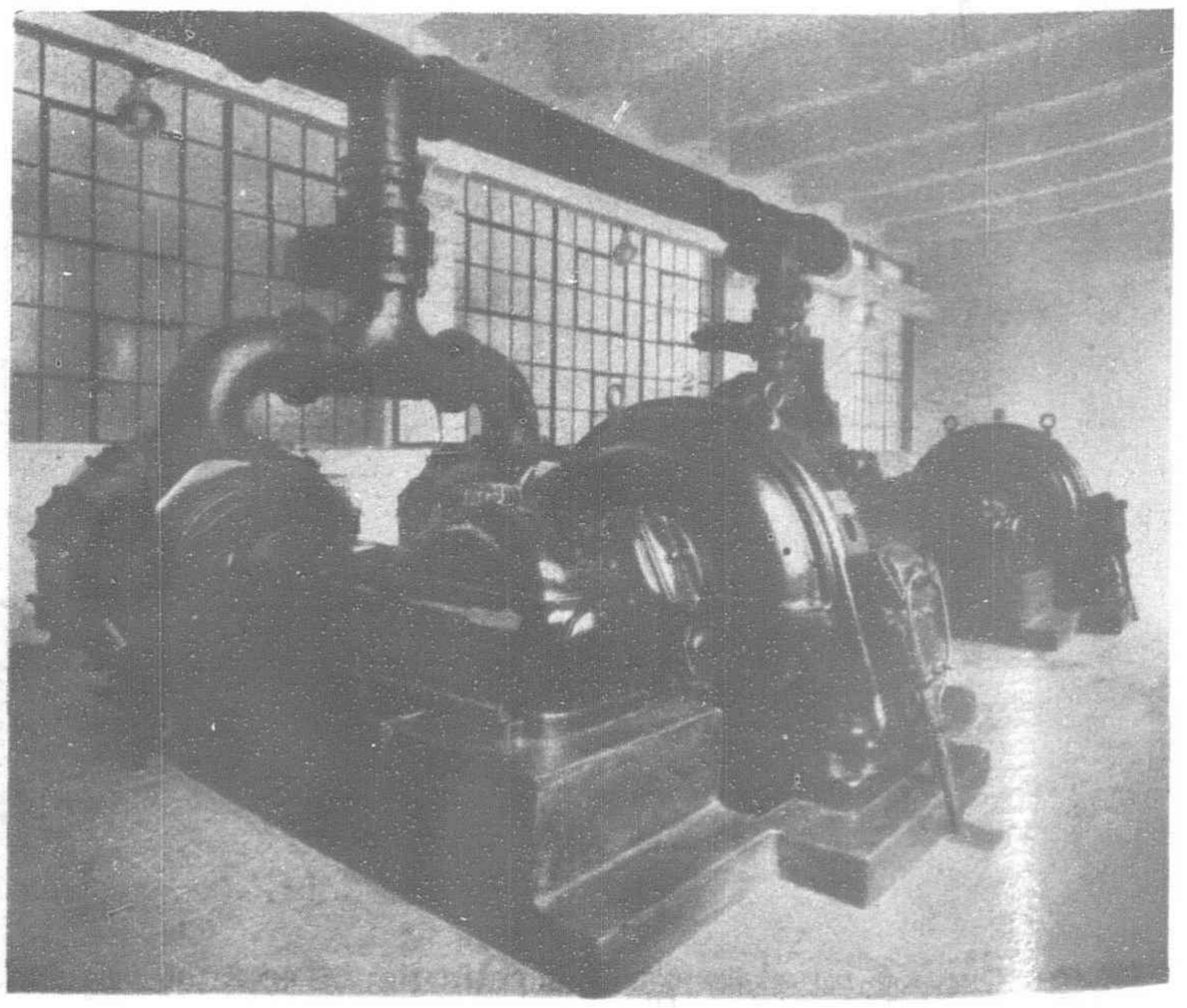
The construction and working of a gas holder is extremely simple.

It consists of a flat-bottomed steel tank which is filled with water. When there is no gas in the holder, the three telescopic lifts sit on rest-blocks on the bottom of the tank. The inner lift has a trussed crown and at the base of the lift a U-shaped cup is attached to the external perimeter.

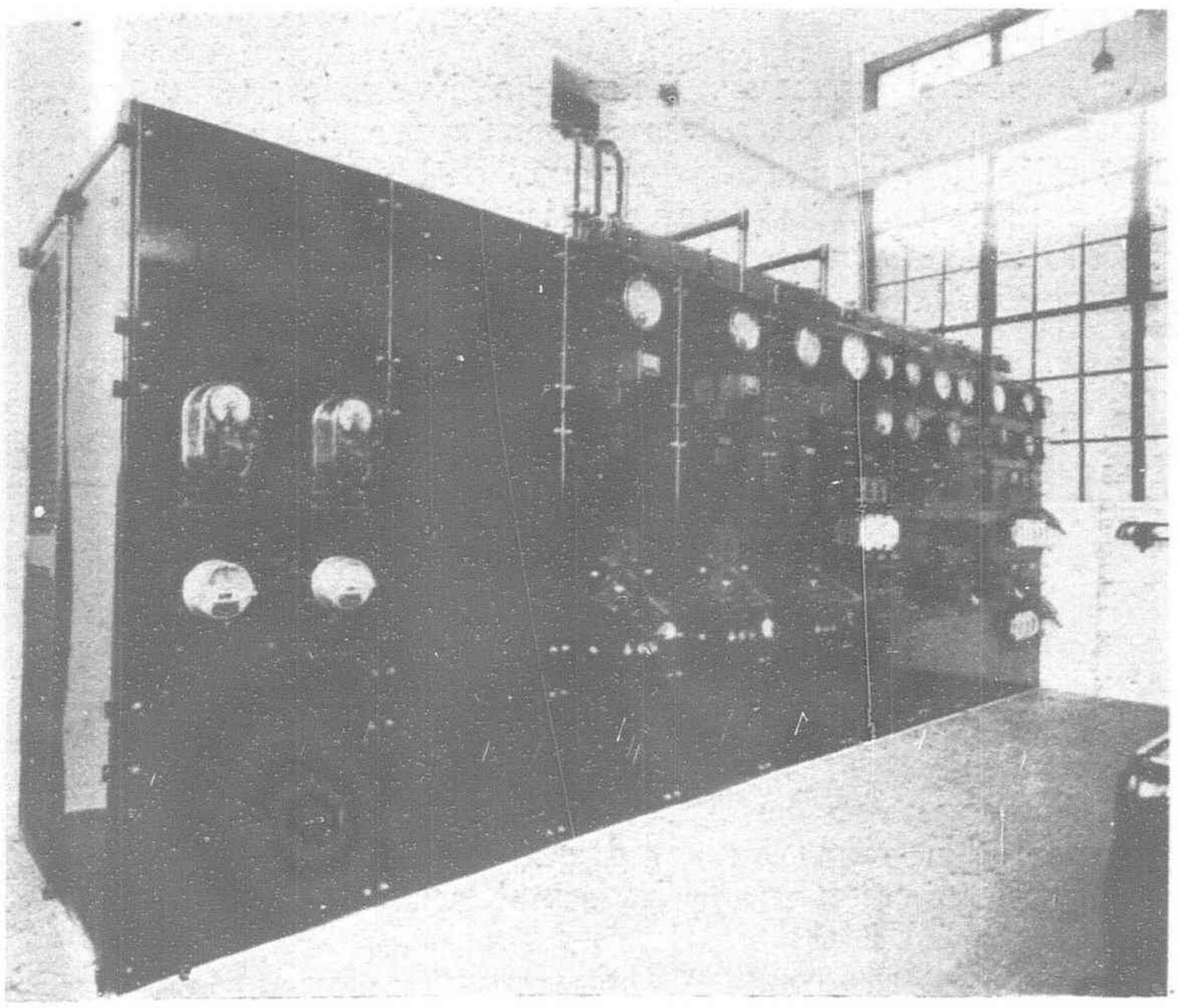
When gas enters the holder, the pressure exerted by the "Exhauster" pushes the inner lift upward until its U-shaped cup engages in an inverted U-piece known as the grip attached to the top of the inside of the perimeter of the second or middle lift and both lifts rise together. The cup on the inner lift when rising is filled with water from the tank, and forms a seal so that gas cannot escape between the cup and the grip. At the base of the second lift



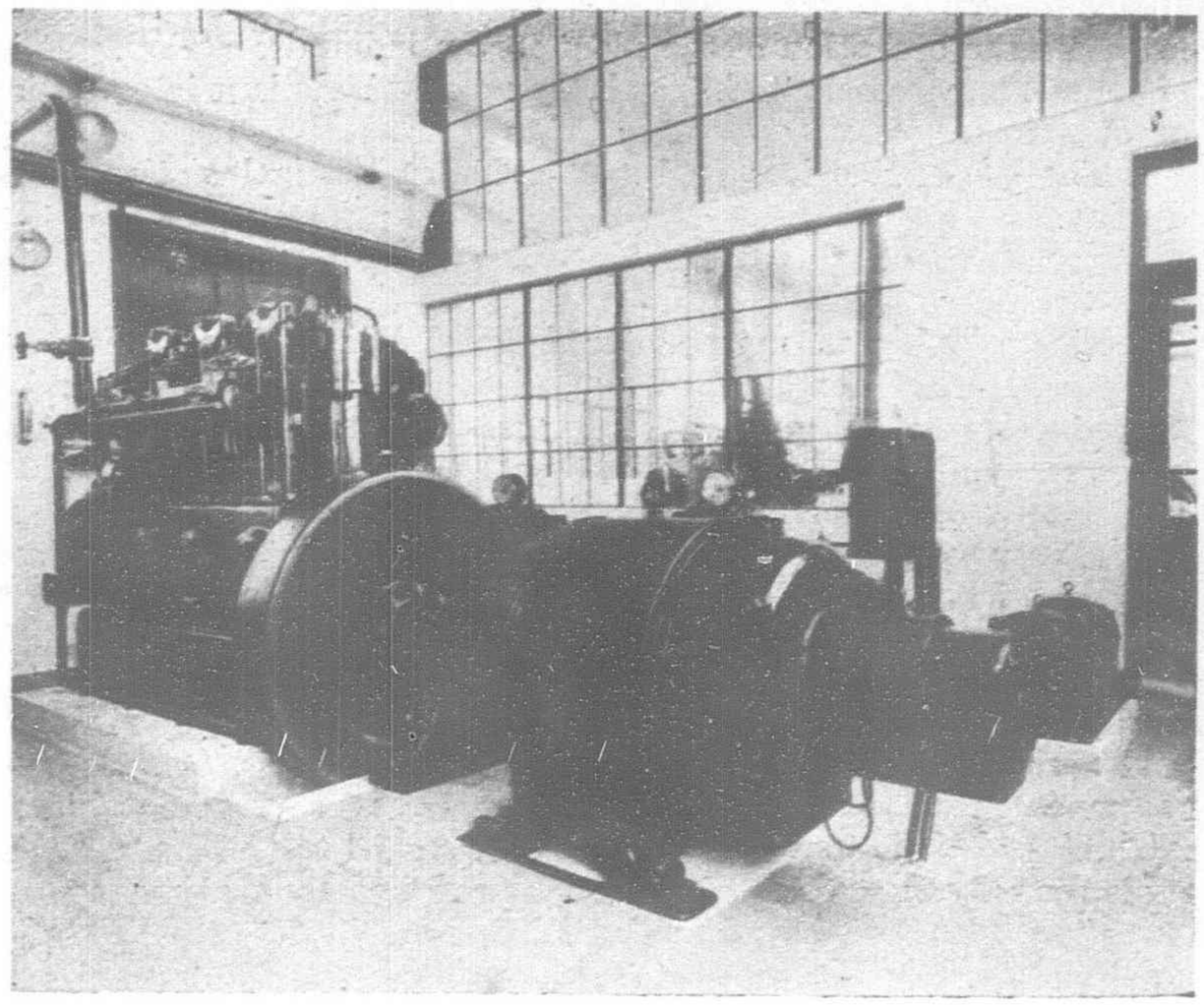
Showing Holmes Connersville Meter



Showing Ingersoll Rand Compressors



Showing the Switch-board



Gas Engine Driven Alternator

a U-shaped cup is attached to the external perimeter of the lift which engages in a U-shaped grip fitted to the inside of the top of the outer lift. This system of cup and grip can continue up to five or six lifts, depending on the height and diameter of each lift. A spiral guided gas holder of the water tank type has been erected having a capacity of 12 million cu. ft. of gas.

The gas holder as erected at the Shanghai Works is used merely as a cushion between the quantity of gas made and the quantity pumped to the main distributing gas holders at Thibet Road. It is the dead weight of the latter holders which throws sufficient pressure (seven inches W.G.) to supply gas through suitable governors and thence through the city distribution mains to the consumer.

Transfer of Gas to Thibet Road for Gas Holders

Gas is transferred to the Thibet Road Gas Holders through 6.686 miles of pipe line of spun cast pipes 14 inches diameter by 18 feet long supplied by Messrs. Stanton Iron Co. of Nottingham. The type of joint used is the "Stanton Wilson Joint," which appears to be new in Shanghai.

The chief advantages of the joint are :—

The speed at which it can be made,

Its ultimate tightness,

The extraordinary amount of movement in the pipeline that can be taken up by the joint without producing leakage.

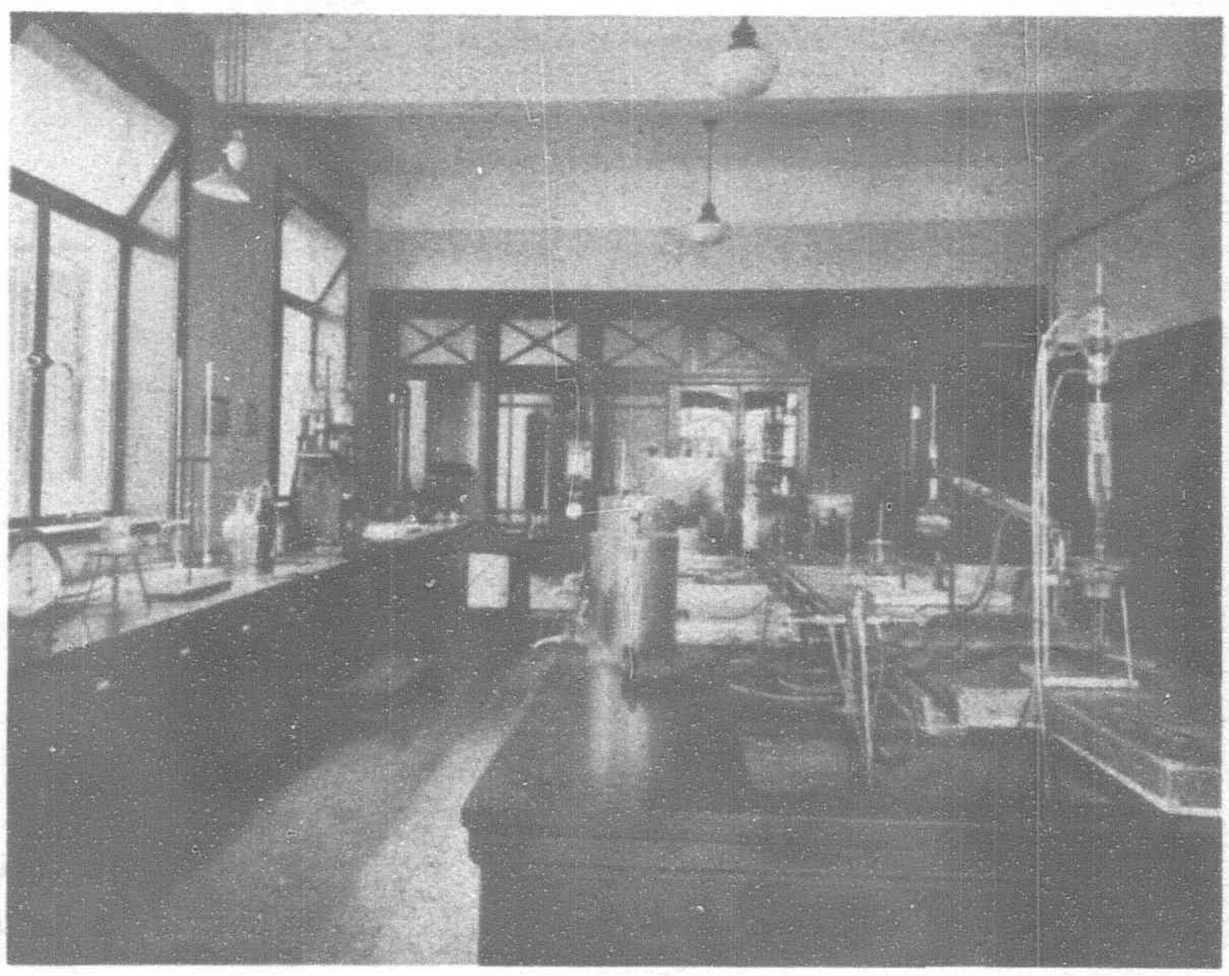
The joint consists of a specially turned socket with three lugs cast on the outside, the faces of which are helical. The spigot end is quite clear. A lead protected rubber ring is placed round the spigot which is inserted into the socket and a cast iron collar is drawn over the socket.

The collar has lugs which are helical and which engage with the lugs on the socket of the pipe. By a slight turning action of the collar an axial movement takes place which compresses the joint.

The collar is turned round by means of a racket.

Gas is pumped through the 14 inch diameter pipe line from the Yangtszepoo Holder to the Thibet Road Holder by Ingersoll Rand Compressors in duplicate, each of 182 h.p., capable of passing 200,000 cu. ft. gas per hour at maximum output, and driven by Crompton Parkinson Auto Synchronous Motors. An arrangement of pocket valves allows the output per compressor to be easily adjusted to $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ and full load.

To arrive at the economical diameter of a suitable pipe line one must compare the capitalized cost of the pipe line plus the complete installation cost of same with the capitalized cost of the compressing machinery, plus the power cost of operating such machinery. In our case the 14 inch diameter pipe line was considered the economical size.



The Laboratory

Power Supply

The supply of electric current is taken from the Shanghai Power Co., through a dual supply at 6,000-volts to the transformer. The whole of the electrical installation was completed by Messrs. Scott, Harding Ltd. of Shanghai, all the electrical equipment being supplied by Messrs. Crompton Parkinson Ltd., of Chelmsford. All motors are of the squirrel cage type. The main control switch-board comprises nine panels :—Main Lead In panel, No. 1 Compressor, No. 2 Compressor, Coal and Coke Handling Plant, Three-Phase Alternator, Lighting, Workshop, etc., and two spare panels.

The power required for the Coal and Coke Handling Plant is carried from the main switch-board to the subsidiary distribution switch-board by an underground cable. The subsidiary switch-board is of the totally enclosed ironclad type, consisting of :—

Coal into store panel, coal out of store, coal breaker, lip gravity bucket conveyor, telpher, coke screening and lift panels.

The Coal Handling Plant and Conveyors are arranged with a system of emergency push buttons, so that by pressing any one button the power supply is cut off to all the conveyors, etc., preceding the conveyor to which the operated button is attached. This prevents any piling up of coal should the operation of any one conveyor fail.

As a standby against prolonged electrical breakdown, the electrically driven compressors are duplicated by two steam-driven Ingersoll Rand Compressors, each of 60,000 cu. ft. output, and transferred from the Thibet Road Works.

All the remaining electrically driven plant is cared for by a gas

engine driven 3-phase alternator, of sufficient power output to maintain the operation of the plant for an indefinite period. It is, of course, unnecessary to have all the mechanical plant in operation at one time.

The gas engine is a 90 h.p. 3-cylinder Vertical National Gas Engine.

Carburetted Water Gas Plant

This plant was manufactured by Messrs. Humphreys and Glasgow, Ltd. of London, and comprises two sections, each having a productive capacity of approximately two million cubic feet of gas per day.

It may be here remarked that a water-gas-plant produces gas by the action of steam on a fuel-bed of incandescent coke contained in a firebrick-lined cylindrical steel generator. The process of gas manufacture is intermittent, periods of gas-making when steam is passed through the fuel bed alternating with periods of air-blasting when the fuel is raised to the requisite temperature for gas-making ; air-blasting alternating with gas-making every few minutes. Water-gas made in this way has a calorific value of approximately 290 B.Th.U. per cubic foot, which can be increased to 650 B.Th.U. per cubic foot, by the addition of oil-gas produced by spraying gas-oil on to the heated checker-brick which is contained in the fire-brick lined vessels, through which both the water-gas and the generator-blast-products are passed.

Carburetted water-gas is used as an auxiliary to coal-gas manufacture, and plant of this nature possesses the great advantage that it can be brought into full productive capacity from cold within an hour or so. It is, therefore, invaluable, as a standby for emergencies, and for taking up irregularities and peak-loads in gas requirements.

The plant is of Messrs. Humphrey's and Glasgow's latest type, the various working valves being operated by hand. It incorporates the makers' new back-run process, which greatly increases the general efficiency of the plant, and is in every way a marked advance upon the existing plant in the old works, certain parts of which are being used in the construction of the new plant. A maximum of ease, and convenience in operation, is secured in the modernized installation, the operating-handles and levers being conveniently grouped, and the heavier valves being provided with a special counter-balanced device.

Air-blast is obtained by duplicate steam turbine-driven fan-type blowers, and special grit-arresters are provided on the smoke-stacks to remove dust and grit from the blast products, which are discharged into the atmosphere.

After leaving the generating plant the gas passes through a hydraulic washer to new high-duty horizontal-tube type condensing-plant, and thence to the water gas relief holders.

The plant is installed in a steel frame reinforced concrete panelled building incorporating overhead coke-storage hoppers, arranged directly below the Telpher, which transports coke from the retort-house to the coke-storage yard. Coke is fed by means of gravity from these overhead storage-hoppers to the generators.

The outlet pipe from the water gas relief holder connects up to the inlet to the "Exhauster" from which point coal gas and water gas mix and proceed through the wet and dry purification plant into the main gas holder.

Steam Supply

The manufacture of water gas requires a large quantity of steam, and boiler plant comprising two 30-ft. by 9-ft. and one 28-ft. by 7-ft. Lancashire boilers have been installed.

These boilers are of suitable capacity to provide steam to the whole works plant should the production of steam from the waste heat boilers fail.

The boilers are housed in a building of reinforced concrete and brick construction. The boiler setting is arranged with an R/C chimney 125 feet high and five feet in diameter.

Water Supply

The water supply for plant purposes is attained from the Whangpoo River. Two electrically driven centrifugal pumps, each having an output of 10,000 gallons per hour, pump water from the river into an R/C settling tank 100 feet by 10 feet, where it is treated to remove all solids and heavy sediment, after the precipitation of which it is pumped through two high pressure gravel filters to an overhead tank, from where it gravitates to the various sections of the plant.

During the summer, Whangpoo river water treated in such a manner would attain a temperature approaching 90° F. which is not suitable for gas cooling purposes and for water cooled bearings. To counteract this feature an artesian well has been drilled to produce 20,000 gallons of water per hour at a temperature of 70° F. at the head of the bore.

The Treatment of Tar

The treatment of tar to produce useful saleable commodities has received special attention and two 12-ton Pot Stills for the production of pitch or refined tar have been installed.

A continuous Tar De-hydration Plant supplied by the Thermal Industrial and Chemical (T.I.C.) Research Co., one of the associated companies of the Woodal-Duckham Vertical Retort and Oven Construction Co., Ltd., will distil 15 tons of tar per 24 hours, producing any desired quality of refined tar with its accompanying proportion of tar oils.

It may here be stated that during the past few years the universal demand for improved road tar binding material has necessitated the development of improved methods of tar treatment, the latest of which is the T.I.C. No. 3 process which has been designed more especially to produce a better quality of road tar from vertical retort tar.

In the T.I.C. plant the tar to be treated is brought into intimate contact with an alloy of low melting point, contained in a suitable still. The alloy can be maintained at any temperature normally employed in the distillation of tar. Intimate contact between the tar and the hot alloy causes the immediate evaporation of some of the oils contained in the tar. The quantity of oil removed in this manner depends on the temperature at which the alloy is maintained. The still is so designed that the vapors leave it quickly, and, by this means, undesirable cracking is avoided. The hot alloy acts as a very efficient medium for delivering the heat from the heat-generator to the tar under treatment.

The amount of alloy in the still is so much in excess of the amount of material being treated at any one moment that the alloy is able quickly to absorb heat from, or give up heat to, the material when sudden changes in working conditions, or in the composition of the tar being treated, occur. In this way the hot alloy acts in a manner similar to the function of a fly-wheel in relation to an engine.

As to the advantage of the process it may be mentioned that instead of filling the still with tar, it is filled with a low-melting point metal, which ensures rapid and uniform heat transmission from the furnace. The tar floats in a film approximately an eighth of an inch deep, on the surface of the metal. Carbon, therefore, cannot accumulate on the bottom of the still, and cause local heating ; and, as only a thin film of tar is in the still at any one time, fire risks are minimized, and priming does not occur.

The time contact between the tar and the heating medium is very short, and degradation of the tar is reduced to a minimum. Tars containing up to 50 per cent of water can be treated with complete safety. By simply altering the rate of feed of the tar it is possible to produce dehydrated tar, road tar, or tar suitable for making bitumen mixtures, and pitch. Distillation takes place at ordinary pressures and temperatures, and the personal attention usually necessary on those systems which work under pressure is avoided.

Owing to the large volume of metal in the still in relation to the volume of the tar present, it has been found in practice, that the plant is extremely flexible in operation, and can be controlled within a few degrees of the temperature required throughout the entire period of running. Another advantage is that there are no complicated parts or pressure release valves to get out of order, and maintenance charges are extremely low.

The metal employed in the still retains its value even after the other parts have ultimately become worn out, and this point of course has to be borne in mind when considering the capital cost of the plant. Any solid deposit which may accumulate on the surface of the alloy can be removed through the manhole covers, and the dangerous pot still practice of sending men into the still is avoided. The pitch or final tar leaves the plant continuously, and the intense gassing and priming common to the discharge of pitch from pot-stills is eliminated.

(Continued on page 332)

Soviet Standard Blast Furnace

Russians Standardize Blast Furnace Design to Effect Economies in Engineering Construction and Purchase of Equipment

By *GORDON FOX, Vice-President, Freyn Engineering Company and OWEN R. RICE, Metallurgical Engineer Freyn Engineering Company*

THE program for the development of the steel industry in the Soviet Union required the construction of a number of blast furnaces. The designing and building of these blast furnaces on a "mass production" basis, substantially as duplicates of each other, offered attractive possibilities for economies, particularly in time and cost of engineering and design, and in producing or purchase of equipment. These economies were even more important under Russian than under American conditions. Government ownership and centralized control made possible the avoidance of "individuality" in designs. Individuality could not be sufficiently justified. It was considered possible to design a "standard" or typical blast furnace which might be adapted, by slight changes, to differences of site conditions, raw materials and product. While it is not considered that the standard blast furnace can be applied universally, its extensive application is deemed practical.

The standard blast furnace was designed by Gipromez (State Institute for Projecting Metallurgical Plants) at Leningrad in conjunction with Freyn Engineering Company, the latter having a force of engineering specialists co-operating with Gipromez. The design conforms quite closely with American practice. A considerable part of the equipment for the initial furnaces was purchased in the U.S.A.

The program for construction of these standard blast furnaces is best indicated in the accompanying table. With the exception of Lipetsk and Tula, all of these furnaces are located at existing or projected steel works of considerable magnitude, which are now under construction. For the time being, the furnaces at Lipetsk and Tula will be of the nature of merchant furnaces.

The Gipromez standard blast furnace is nominally a 1,000 ton unit. While the standard blast furnace is nominally rated at 1,000 tons, the determining elements have sufficient marginal capacity to permit possible outputs of perhaps 1,200 tons at a later date when favorable operating conditions have been organized. The more prominent factors which led to the choice of this size were as follows:

(1) A modern furnace was required, enjoying the advantages of low construction and operation costs per unit output which accrue to large units. The 1,000 ton unit was considered to be a maximum sufficiently well established by contemporary practice elsewhere.

(2) The conditions which will attend the operation of these furnaces, at least initially, did not justify the adoption of extremes. Most of the furnaces are located in entirely new plants in which operating personnel must be organized and trained. Present available transportation equipment does not favor large tonnage operations. Maintenance facilities must be developed. Initially, at least, more than normal delays may be expected.

(3) Flexibility was desired to permit adaptation both as to ores and as to product. The characteristics of the ores available for burdening through the life of the furnaces were in some cases rather indefinite. In no case was there experience as to previous performance of these ores in large furnaces.

(4) Studies involving all factors indicated that in plants of medium size, where most of the standard blast furnaces will be located, three or four moderate sized units have many practical advantages, providing a plant metal balance in continuity of material movements, minimizing of coal, coke and pig-iron stocking, and insurance of and uniformity in gas supply. These factors are of particular import in most of the new Russian plants where about seventy per cent of the open hearth charge will be hot metal and where blast furnace and coke oven gas are to be the prime source of heat.

LOCATION OF STANDARD BLAST FURNACES IN U.S.S.R.

Name of Plant	*Location*	*Illus. in*	*Number of Furnaces*			*Location of materials and distance from furnace*	
			Operating	*Building*	*Projected*	*Ore*	*Coal*
Dzerjinsky	Ukraine, on Dnieper River	—	1	1	5	Krivoirog 125 km.	Don Bas 250 km.
Zaporozhe	Ukraine, on Dnieper River	—	1	1	4 or 6	Krivoirog 125 km.	Don Bas 250 km.
Voroshiloff	Ukraine, Don Bas	Fig. 3	1	1	4	Krivoirog 375 km.	Don Bas Local
Azovstal	Sea of Azov at Mariupol	Fig. 1	1	1	6	Kertch 100 km.	Don Bas 125 km.
Lipetsk	Central	Fig. 5	0	2	4	Lipetsk Local	Don Bas 200 km.
Tula	Central	—	0	2	4	Tula Local	Don Bas 375 km.
Krivoirog	Ukraine, Southwest	Fig. 2	1	1	6	Krivoirog Local	Don Bas 375 km.
Nikopol	Ukraine, Southwest	—	0	0	2 or 3	Krivoirog Local	Don Bas 375 km.
Tagil	North Urals	—	0	0	6	No. Ural District Adjacent	Kuznetsk 1,500 km. Kisel Adjacent
	Total		5	9	41		

Furnace Lines

The brick lines for the standard blast furnace were developed particularly with ores from the Krivoirog district in mind. A number of the new furnaces will use Krivoirog hermatites, which are similar in general character to our Lake Superior ores. Most of the new furnaces are based on using coke produced from Don Bas coal, which is now and probably will continue to be high in sulphur (about 1.75 per cent). Russian furnace operation in this district will be committed to high slag volumes.

The principal dimensions of the standard blast furnace with a typical lining, are as follows:

	Meters	*Feet*
Hearth diameter	7.000	23-ft. 0-in.
Bosh diameter	7.850	25-ft. 9-in.
Stockline diameter	5.410	17-ft. 9-in.
Height:		
Bottom to iron notch	0.507	1-ft. 8-in.
Iron notch to cinder notch	1.420	4-ft. 8-in.
Cinder notch to tuyeres	1.120	3-ft. 8-in.
Tuyeres to bosh	0.507	1-ft. 8-in.
Bosh	3.240	10-ft. 8½-in.
Straight section (bosh)	1.860	6-ft. 1-in.
Inwall	14.720	48-ft. 4-in.
Straight section to open bell	2.920	9-ft. 7-in.
Open bell to platform	2.740	9-ft. 0-in.
Total height, botton to platform	29.034	95-ft. 4½-in.
Bosh angle	80 deg. 31 min. 37 sec.	
Inwall batter	0.0823 per 1.0 m.	1-in per ft.
Bell diameter	3.960	13-ft. 0-in.
Bell slope	50 deg.	
Bell clearance	0.725	2-ft. 4½-in.
Furnace volume	930 cu. m.	32,800 cu. ft.

8 columns, 12 tuyeres.

In the standard arrangement for a blast furnace department comprising several blast furnaces, the furnaces and cast houses are in line, with the stoves and tracks parallel thereto. Except for end furnaces, adjacent furnaces have a common cast house and common stove block.

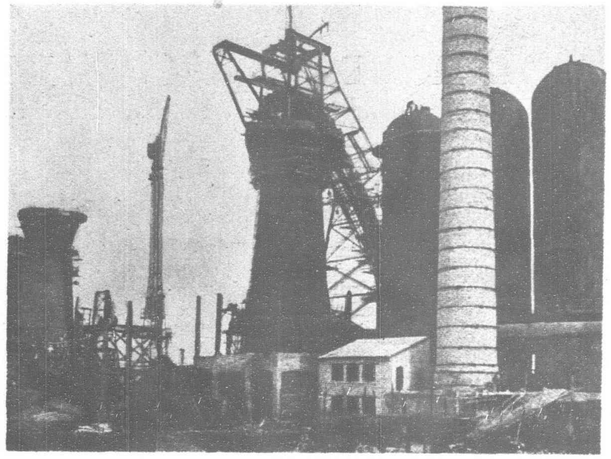


Fig. 2.—Blast Furnace "Komsomolka" at Krivoirog

Three tracks are provided under the skip inclines on the cinder side. Slag can be hauled in either direction from the spotting points. Iron ladles are spotted on stub tracks under the cast house floor, arranged either right or left hand, according to the location of the steel works. Stub tracks also serve the dust catcher. Three tracks are provided on this side of the furnace. Where more than four furnaces will be in line, cross-over tracks will be provided between the fourth and fifth furnaces.

The straight-line arrangement of blast furnaces shows both investment and operating economies over the angular arrangement. It accommodates well the slag granulating system. It is less convenient during construction or repair of one furnace with others in operation. Russian conditions strongly influenced the adoption of the straight-line arrangement. Due to the relatively wide track gauge and the extensive use of four-wheel type cars with rigid axles, large radius track curves are essential. The angular arrangement of cast houses, involving much curved track, occupies larger areas. Moreover, a four-furnace layout with angular cast houses requires more track switches than an equivalent straight-line arrangement. The maintenance of the additional trackage under severe weather conditions is a factor of some import.

Ore Storage and Stock Bins

Many of the iron ores of the Soviet Union require concentration, notably those of Kertch, Tagil, Bakal, and Lipetsk. Sintering plants have, therefore, assumed large proportions.

Decision was reached to divide ores into three classes as to size. These are 0-5 mm., 5-30 mm., and 30-80 mm. All ores falling into the 0-5 mm. class are to be sintered, together with fine dust and mill scale. The other two sizes are to be charged separately.

The Russian Ore Congress adopted the policy of locating ore sizing and sintering plants at the blast furnace plants rather that at the mines (excepting Kertch ores). This policy complicates the ore handling problem by requiring in the ore yard the storage both of raw ore for the ore conditioning plant, and graded and sintered ore for the furnaces. At most seasons a simultaneous flow of material both into and out of the ore yard is involved. In addition

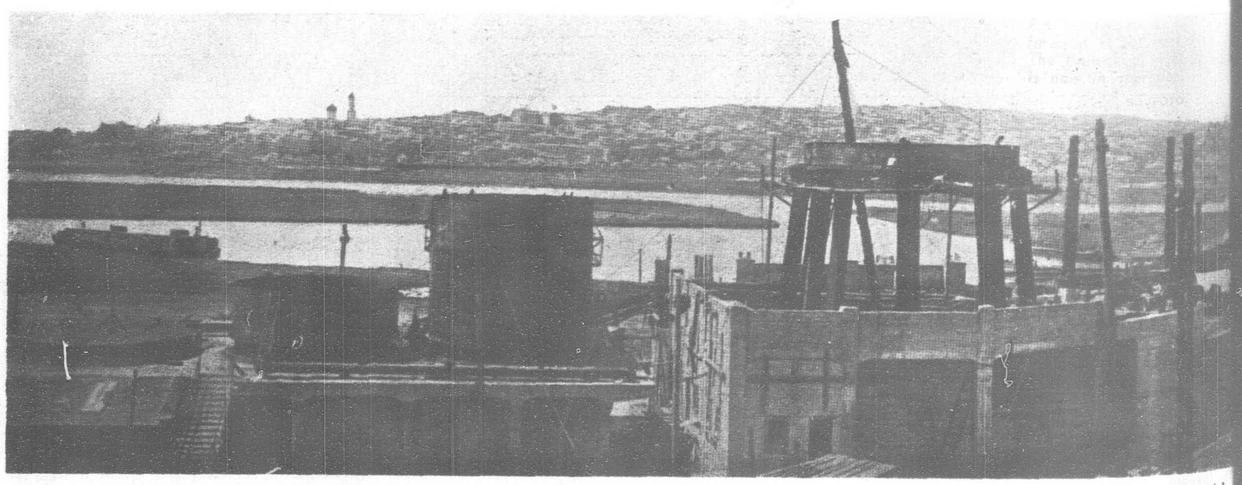


Fig. 1.—Two Standard Furnaces at Azovstal.

there is a fluctuating traffic of raw ore direct to the conditioning plant, and of conditioned ore direct to the furnace.

Ore handling is predicated upon rail transport from mines to furnaces, except for Azovstal which will receive ore by water transport from the concentrating and sintering plant at Kertch. A gradual replacement of the present conglomeration of cars (15 ton four-wheel, flat-bottom wooden gondolas, box cars, 25 ton hopper bottoms with side discharge, and occasional 60 ton American type steel hopper cars) with a standardized 60 ton car is contemplated. This car will be suitable for car-dumper unloading, an operation now generally impossible. Accordingly initial arrangements are for hand unloading to storage with provision for car dumpers as a future possibility.

Two concrete track trestles under the ore bridge discharge to a common trough between them. The length of the trestles and trough conform to the length of the furnace stock bins. The total unloading track length allows four hours per shift of cars for hand unloading, sufficient to meet current furnace consumption and to develop a 2½-mo. reserve. This reserve is based on anticipated retardation of rail traffic in winter.

To provide for raw ore from storage to conditioning plant, two reloading tracks are arranged outside the shear-leg of the ore bridge under the cantilever.

Liberal ore bridge capacity is required. Two bridges are indicated for a two-furnace plant and three for a four-furnace plant. The design adopted has a span of 76 m. (250-ft.) with cantilever 16.5 m. (54.0-ft.) on the furnace side and cantilever 18 m. (59-ft.) on the unloading and reloading side. The bridge has a 10 ton man-trolley with free stocking capacity of 550 tons per hour. The height of the bridge permits 17 m. (56-ft.) ore piles.

The normal ore-storage for a four-furnace plant is 525,000 tons, plus 36,000 tons of limestone. This is a 2½-mo. ore reserve.

The furnace stock bins are arranged in a double line. Designs were made both for steel and for reinforced concrete bins. The latter type were used at the initial plants due to stringency of steel. There are 26 bins per furnace, each bin having 106 cu. m. (3,740 cu. ft.) effective capacity. They are conventionally allocated as follows:

Ore	14 bins—3,556 tons, 48-hr. supply
Limestone	6 bins—1,020 tons, 40-hr. supply
Scrap	1 bin
Miscellaneous	4 bins
Empty	1 bin

Freyn-Design bin gates of the Orr roller type are provided. These are operated from the scale car. This type of mechanical gate was adopted as the fastest and most accurate means of loading the scale car.

Coke is handled in two central coke bins of 646 cu. m. (22,800 cu. ft.) combined capacity. There is storage for 310 tons of coke, about eight hours supply.

The bins and trestle carry three tracks. The ore transfer car track and the coke track are electrified. The track above the stone, scrap and miscellaneous bins is not electrified.

The stock house is totally enclosed with brick walls, with windows and openings provided for ventilation. Initially, at least, coke salamanders will be used for heating.

A two-compartment Atlas type scale car is provided, having 4.5 cu. m. (160 cu. ft.) capacity in each compartment. A scale car repair pit is provided at the end of the stock house. Inclined trackage permits movement of any scale car to yard level and a lay-off spur track permits placing any scale car over the stock house repair pit.

Charging System

The arrangements for charging the standard blast furnace are in full conformity with the most modern American practice. The charging cycle is based upon the following volumetric capacities:

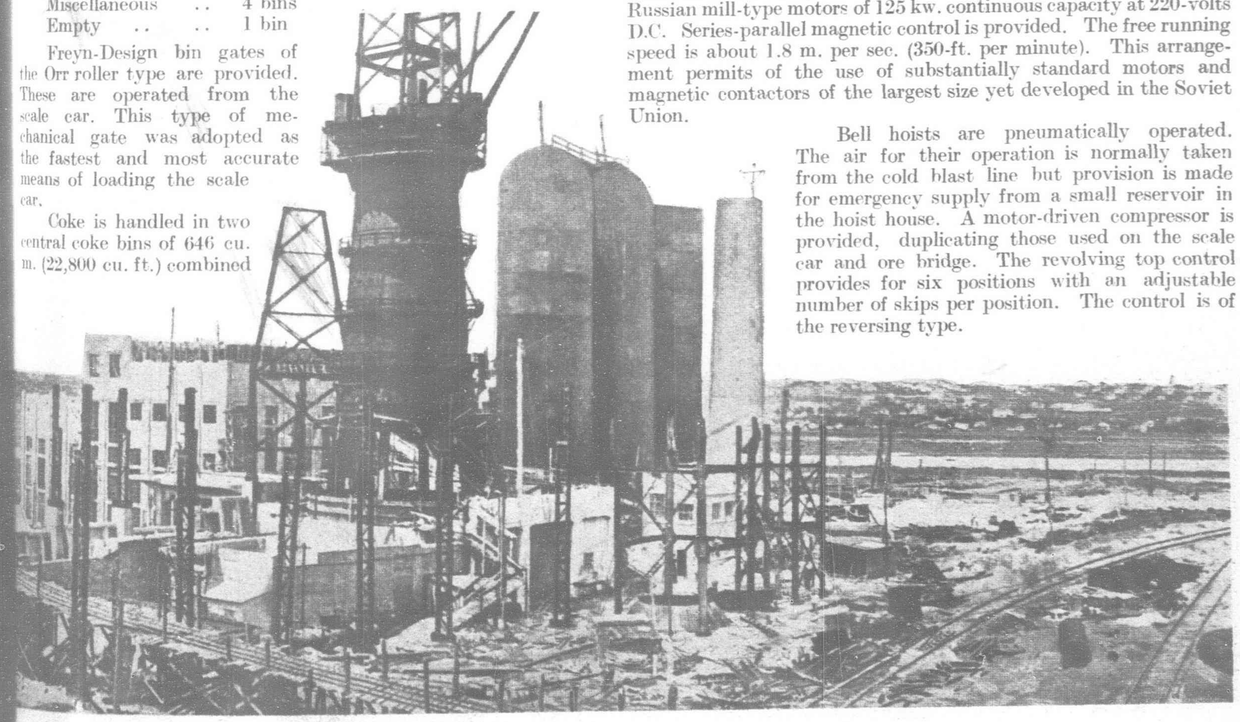
Skip hoist tub	6 cu. m. (212 cu. ft.)
Hopper above small bell	6.45 cu. m. (227 cu. ft.)
Hopper above large bell	21 cu. m. (740 cu. ft.)

This skip tub volume is somewhat larger than is normal to American furnaces of this size. On the one hand, this skip volume affords satisfactory depth of a coke round comprising either two or three skips. On the other hand, it permits ample charging capacity with a minimum number of rounds per day. Such a charging program gives a maximum of leisure for scale car operations and permits moderate operating speeds of all charging mechanisms, minimizing their first cost and avoiding the troubles caused by impact stresses associated with high speeds.

Provision is made for automatic weighing of the coke charge. The coke passes from the central coke bin over rotating grizzlies to either of two weigh-hoppers, thence to the skips. The arrangement is such that no operator need be present during the coke charging operation. The desired number of skip-loads of coke are weighed and sent to the furnace automatically. This arrangement affords to the scale car operator ample time to load ore, stone, etc., while the coke rounds are being charged.

The skip tubs are of bail type. The skip hoist is a single drum machine conforming to American design and equipped with two Russian mill-type motors of 125 kw. continuous capacity at 220-volts D.C. Series-parallel magnetic control is provided. The free running speed is about 1.8 m. per sec. (350-ft. per minute). This arrangement permits of the use of substantially standard motors and magnetic contactors of the largest size yet developed in the Soviet Union.

Bell hoists are pneumatically operated. The air for their operation is normally taken from the cold blast line but provision is made for emergency supply from a small reservoir in the hoist house. A motor-driven compressor is provided, duplicating those used on the scale car and ore bridge. The revolving top control provides for six positions with an adjustable number of skips per position. The control is of the reversing type.



The furnace at right is now in operation

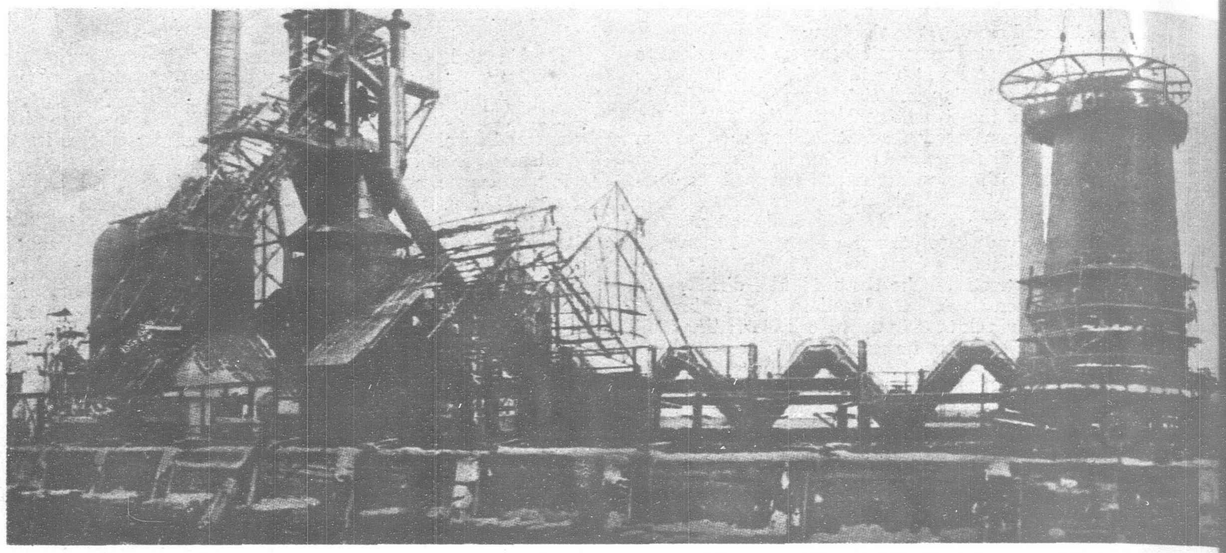


Fig. 3.—Panorama of furnaces at Voroshiloff. No. 1 Furnace at Left and No. 2 Furnace Center are of standard type. At Extreme Right is old furnace plant

Each furnace is provided with two Freyn-Design Continuous Stockline Recorders which indicate the movement of the burden at two opposed points. The charging equipment including skip, bells, revolving top, and stockline recorders is fully interlocked and sequenced through the use of a Freyn-Design Charging Control.

Iron and Slag Handling

Provision is made for spotting three iron ladles at each furnace. Three slag ladles of 11 cu. m. (390 cu. ft.) are provided, also one additional ladle common to two furnaces. This provision suffices for 1,000 tons daily iron production and 60 per cent slag volume. The slag granulating system approximately doubles this slag disposal facility.

Iron ladles are of 80 tons capacity. Both open top and Kling type ladles are in use at different plants. The possible adoption of a standard type will depend upon operating results.

Provision is made to granulate slag at each furnace. The granulated slag is flushed down a flume common to a number of furnaces, and accumulates in a pit sufficiently remote from the furnace site to prevent traffic congestion. This expedient segregates under central control the difficulties incident to the handling of wet granulated slag in cold weather. The pit will hold a 12 hours accumulation of slag. It is spanned by a gantry crane having a 4-cu. m. (5 cu. yd.) grab bucket. For a four-furnace plant, reloading facilities at the slag pit have a capacity of 2,400 tons of granulated slag per day.

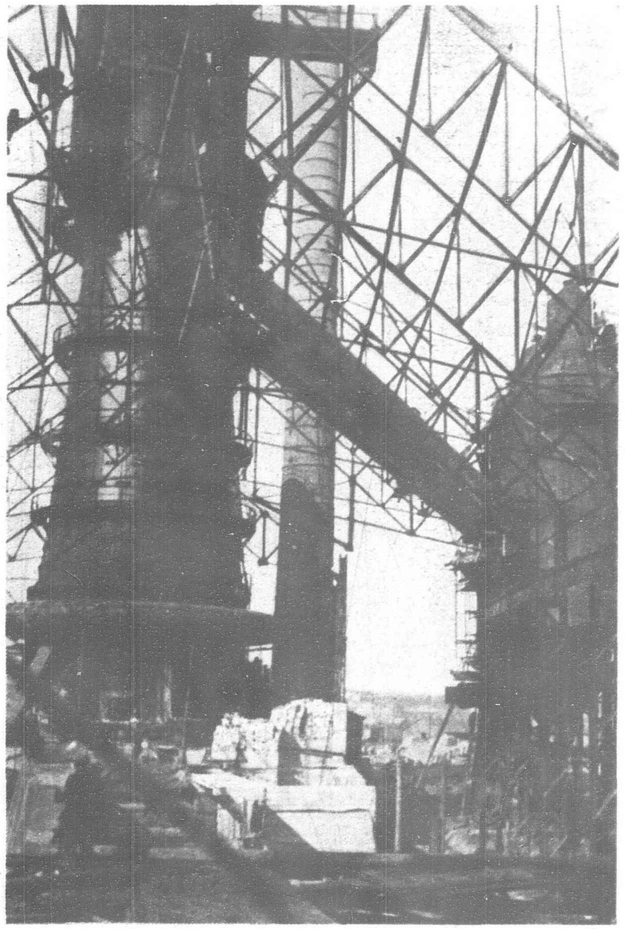


Fig. 4.—Close-up of No. 1 Furnace at Azovstal

Two loading tracks, served with an electric car haul, provide for spotting 16 cars. Slag in ladles can be granulated at the pit, provision being made for spotting seven ladles.

Because of the scarcity and cost of water at most Russian plants, provision is made for recirculation of flushing water. There is a system of weirs both in the slag pit and in a separate water sump whereby the water is free from the granulate. The water supplied for granulation approximately offsets the loss in evaporation and the moisture in the granulate. The granulated slag will be hauled in cars to cement plants, which will be located near the blast furnace plants. Thaw houses are contemplated at the cement plants in view of probable freezing difficulties.

Hot Blast Stoves

Three stoves, 7.8 m. dia. by 30.5 m. height (25-ft. by 97-ft.) are provided for each blast furnace. Space is reserved for the possible future construction of a seventh stove common to two furnaces.

Checker work was selected such that brick could be reliably manufactured under present conditions by Russian refractory plants. The Kuehn type of checker with straight brick is employed. The top section of checkers has openings 110 mm. (4.3-in.) square with 60 mm. 2.4-in.) thick brick; the intermediate zone has 45 mm. by 117 mm. opening (1.8-in. by 4.5-in.) with 45 mm. (1.8-in.) brick; the bottom zone has 45 mm. openings with a special cross brick 40 mm. (1.6-in.) thick. The checker work is carried on cast iron columns and grid plates.

The total heating surface per stove is 16,000 sq. m. (173,000 sq. ft.). The total weight of brick work is 1,700 tons. Block type insulation 75 mm. (3-in.) thick with 90 mm. (3½-in.) over the dome, is specified. The waste gas flue is located centrally under the stoves in the main foundation block. Seven stoves have a common stack 60 m. (197-ft.) high. Stove efficiencies of 85 per cent are anticipated.

Accessories for the standard stove include Freyn-Design Pressure Burners. The hot blast valve is a 900 mm. (35½ in.) Freyn-Design gate type. It is operated by means of a small hand winch. All fittings are at present arranged for hand operation but may be adapted to automatic operation.

Fig. 5.—One of the Two Standard Blast Furnaces under construction at Lipetsk

At all plants it is proposed to clean all of the gas. At Voroshiloff, Dzerjinsky, Zaparozhe and Azovstal Works, Theisen type disintegrator swill be used. At all of these plants except Voroshiloff, water will be quite plentiful. It is also proposed to used disintegrators at Tagil Works. The choice of disintegrators for the first furnaces built was dictated in a large measure by the fact that this method of cleaning is proven as to performance. At all of the other plants, now in the initial stages of construction, it is proposed to use the electric precipitation method. Electric precipitators are now being developed and built in the Soviet Union. The initial installations are being made at Tula and at Lipetsk plants. The electric precipitator is attractive because of the shortage of water at some plant locations.

Singapore Sanitary Improvement

The modernization of the sanitation system of Singapore is under discussion, and the Municipal Commissioners have obtained the services of a well-known expert, Mr. Watson, of the English firm of Dodd and Watson. There are at present several schemes already prepared, together with estimates for the connection of all areas within Municipal limits not yet provided with a water carriage system. The question of purification work at Serangoon is also being discussed, but consideration of the schemes has been deferred pending further investigations as to the possibility of discharging crude sewage, or partially-treated sewage, into sea. Whether a separate disposal station will be provided or whether the present establishment at Alexandra Road will be enlarged will have to await the consultant's visit. Up to the end of 1932 the total length of sewers laid down in Singapore was just under 62 miles, and the total number of connections to sewers at that time was about 5,000. New work has been undertaken since then, but not to any large extent. A new pumping station has been provided at Alexandra Road.

Japanese Funicular Railway Lines

By W. HARVEY CLARKE, Jr.

THE Ikoma-san Funicular Railway was opened August 29, 1918, at the town of Ikoma, Nara Prefecture, as the first enterprise of its kind in Japan. Situated not far from Osaka and Kobe, the leading commercial cities of Western Japan, and also from the well known tourist centers of Kyoto and Nara, this novel means of elevation immediately caught the public's fancy, perhaps originally due to curiosity. Against the cost of construction, its first fiscal year showed a favorable profit of 27.6 per cent. Such success, much greater than anticipated, was sufficient indication of bright prospects for similar enterprises projected for other parts of the country. Consequently, it was followed by the establishment of other cable lines on various mountain sides noted for scenic as well as historic interest.

To-day there are 24 funicular lines in operation, three are under construction and licenses have been granted for nine additional lines. They are widely scattered throughout Japan—except in the districts of Tohoku, Hokuriku and Hokkaido, which do not have any. According to geographical distribution, these lines are most numerous in the Kinai and adjacent districts (in which Kyoto, Osaka, Kobe and Nara are located). The Kwanto district (with Tokyo and Yokohama) is next in numerical importance. Cable lines usually are operated on mountains noted for temples or shrines, or having scenic attractions which draw worshippers or sightseers, whose chief purpose is a pilgrimage or a pleasure trip.

The economic features surrounding the 24 funicular lines in Japan to-day are not unfavorable. Only eight of them were open in 1925, and a definite conclusion regarding their financial status still depends upon future records. It must be remembered that such cable lines as the one at Ikoma, operated by the Osaka Electric Railway Company, the one at Mt. Shigi by the Shigi-Ikoma Electric Railway Company, and the one at Hiei-zan by the Kyoto Electric Light Company, and the Goro line by the Hakone-tozan Electric Railway Company, are not always self-supporting, for they were built primarily to feed surface lines. But little emphasis, therefore is placed on their economic status. If a satisfactory profit is not derived from their funicular lines, the promoters consider them an investment in advertising. Then, the public appreciates these novel lines as affording an easy means of access to noted elevated points and sacred precincts long inaccessible to many people.

Below are given short descriptions of each of the 24 lines now in operation :

The Ikoma-San Line

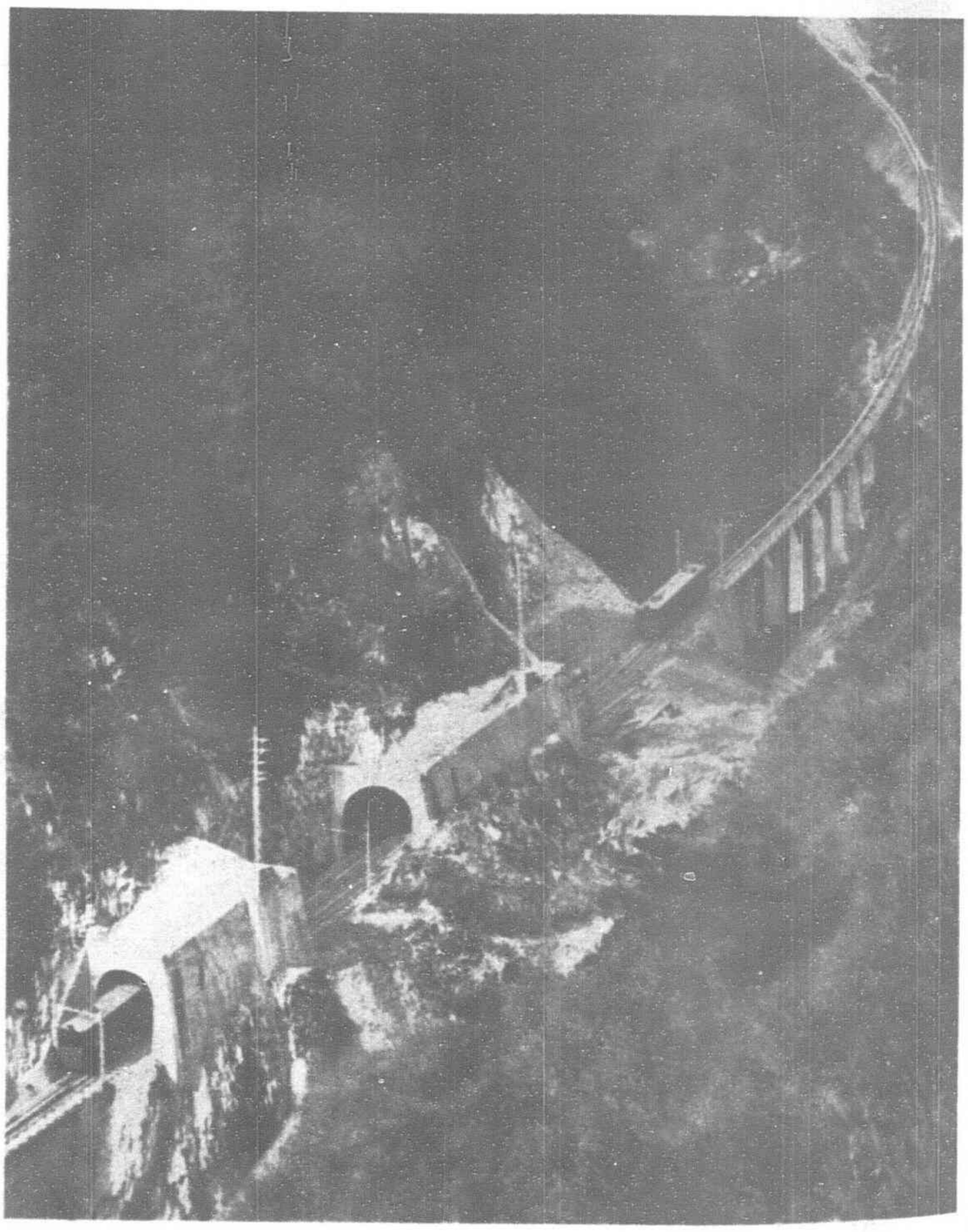
1. *Ikoma-san Funicular Railway.*—Operated by the Osaka Electric Tramway Company at Ikoma-machi, Ikoma-gun, Nara Prefecture.

Date of opening	August 29, 1918
Length of line	.7 mile
Difference of altitude between terminal stations	508.22 feet

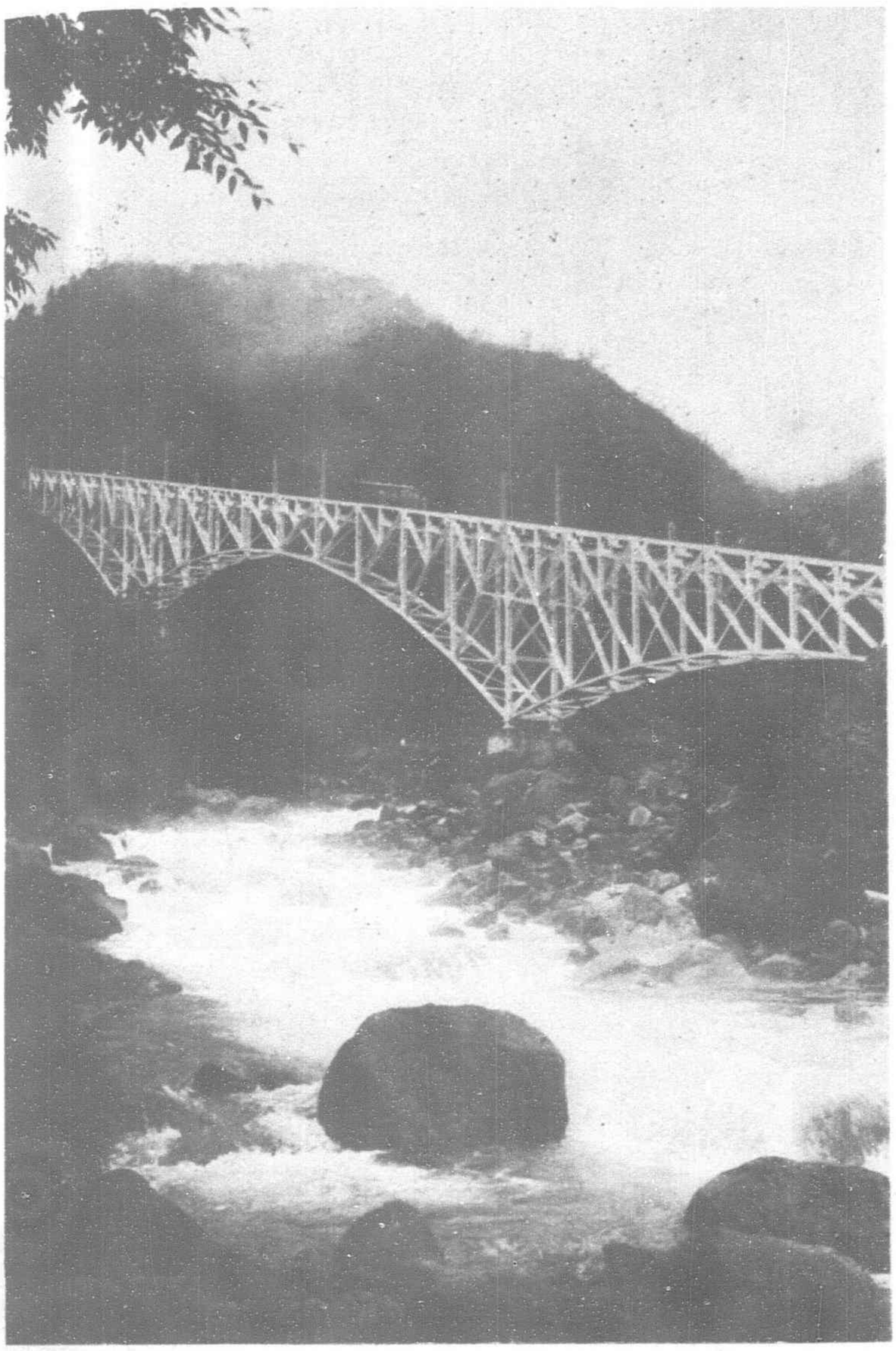
Traction cable :

Diameter	30 mm.
Type	Hercules rope : 6 strands of 22 wires with hemp core.
Weight	3.8 kg/m.
Breaking strength	69,500 kg.

General view of 1,300 meter Shiki-san Kyuko Cable Line from Shikisan-guchi (61 meters) to Takayasu-yama (415 meters). Opened December 15, 1930



View of Upper Part of 1,700 meter Rokkogoe-Arima Funicular Railway near Summit Terminus Visible in Background, from Dobashi (Altitude 244 meters) to Rokko-san (738 meters), Opened March 10, 1932



Structural Steel Bridgework Spanning Daiya River along Nikko Funicular Railway

Air Panorama of 803 meter Koya-san Funicular Railway from Gokuraku-bashi (Altitude 538 meters) to Summit of Koya-san (867 meters). Opened June 29, 1930

Electric drive (Theodore Bell) :

Voltage	440-volts A.C.
Motor develops	110 h.p.
Diameter of 3-groove main sheave	3,200 mm.

Cars :

Weight each	8,200 kg.
Capacity	56 persons
Construction cost	Y.121,806 for purchase— Y.605,266 additional
Running time	7 minutes
One way fare	12 sen

The Ikoma-san cable line begins half way up Mt. Ikoma (on its Yamato side) at an altitude of 2,120 feet in the Ikoma range, which runs from north to south for 27.5 miles along the border of the provinces Yamashiro, Yamato and Kawachi. A 30-minute run by the Osaka Electric Tramway from its starting point at Uenon-machi brings the passenger to Ikoma Station, reached directly through the 11,000 feet Ikoma tunnel, with its broad gauge double track ; whence the funicular line leads up to Ikoma-machi, where the famous Hozan-ji (Buddhist temple) stands. The town of Ikoma, with a population of approximately 5,000, has grown remarkably since the opening of the cable line. Its people depend chiefly upon visitors' trade. The town is a popular pleasure resort as well as a place of pilgrimage for the near-by cities of Kyoto, Osaka, Kobe and their vicinities.

Hakone-Yama Gora Line

2. *Hakone-yama Gora Funicular Railway.*—Operated by the Hakone-tozan Electric Railway Company at Miyagino-mura, Ashigara-gun, Kanagawa Prefecture.

Date of opening	December 1, 1921
Length of line	.8 mile
Difference of altitude between terminal stations	1,705.4 feet

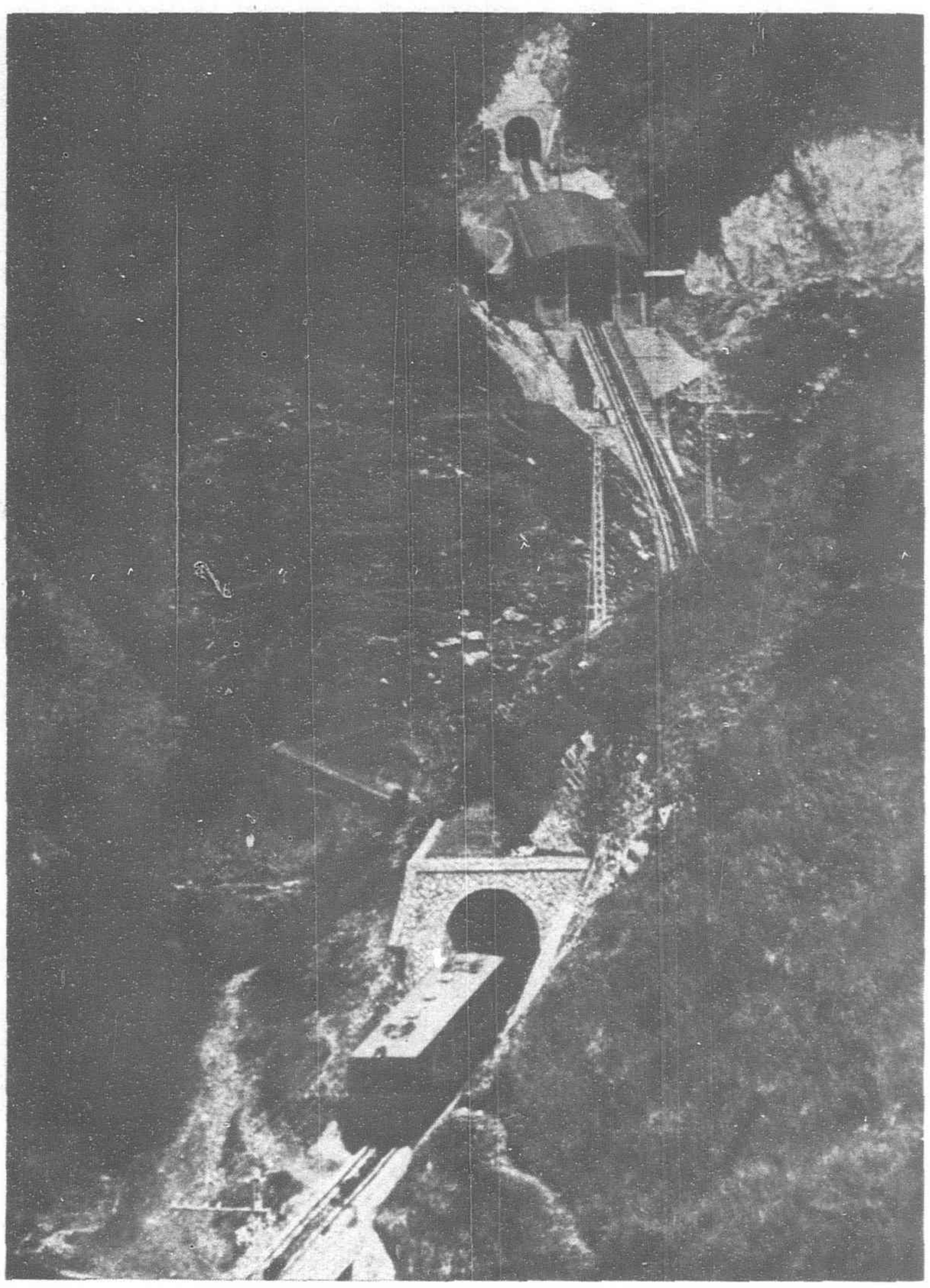
Electric drive (Giesserui Bern) :

Voltage	550-volts D.C.
Motor develops	57 h.p.
Main sheave	3 grooves

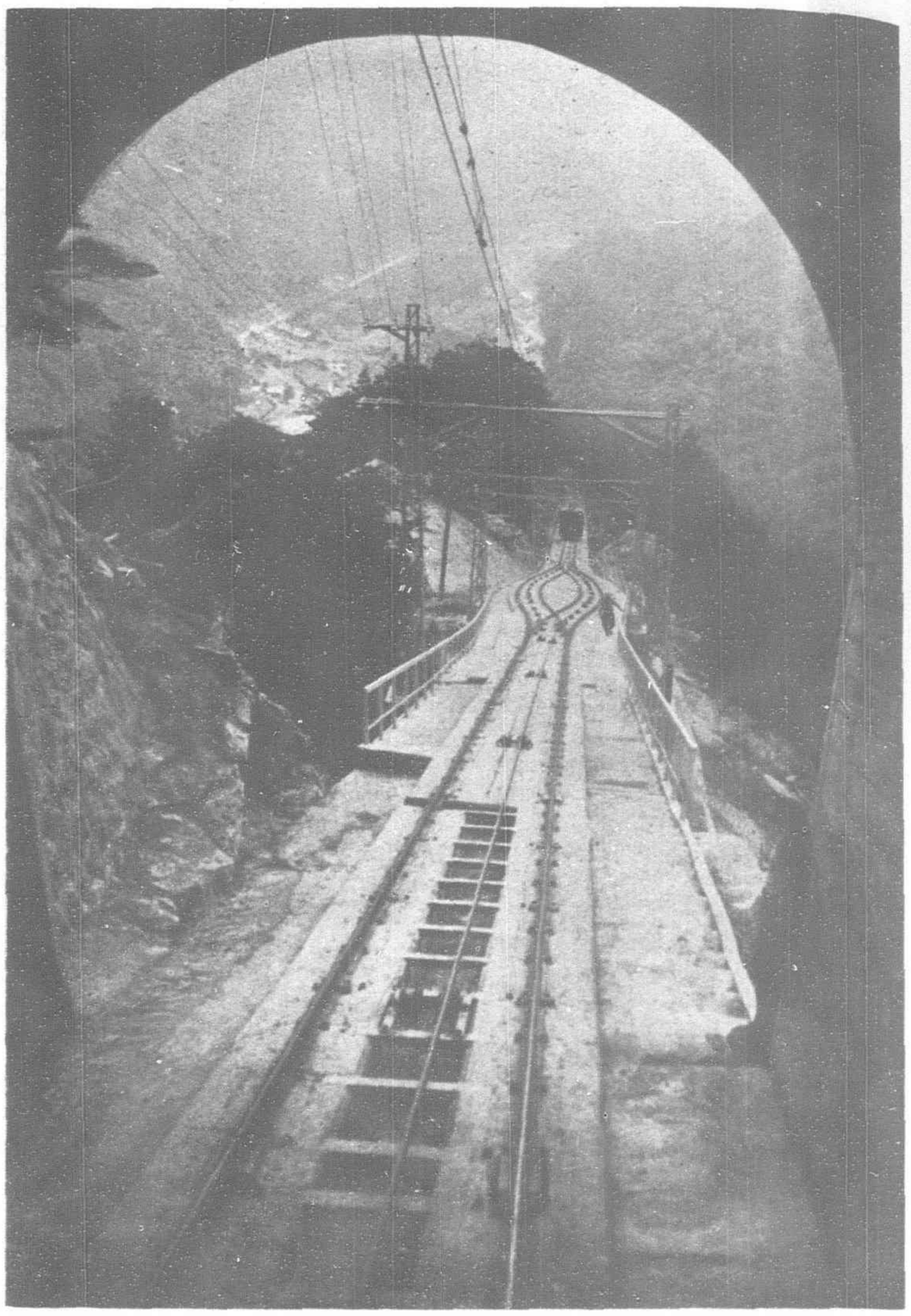
Cars :

Weight each	8,400 kg.
Capacity	26 persons
Construction cost	Y.297,226
Running time	9 minutes
Fare	Up, 25 sen ; down, 15 sen

The Hakone-yama Gora Funicular Railway was opened in December, 1921, three years and three months after the establishment of the Ikoma-san cable line mentioned above. Its purpose is to accommodate travellers who want to take a pleasure trip in the vicinity and the cable line is conveniently laid at Gora, about two miles from Miyanoshita, which is one of the 12 hot springs of the district, extending from the west terminus of the Tozan Electric Railway to Soun-zan, on the way to Owakidani (also called Ojigoku), the largest of the Hakone solfataras. Near the west terminus of the cable line is Gora Park, an attractive suburban development, maintained by the same Railway Company. It is known as a popular year-round recreation ground with a wide prospect of the Hayakawa Valley and the sea beyond. The situation it occupies is favorable, but the cable line does not carry so many passengers as the Ikoma Funicular Railway, because the former is too far from Tokyo, more than four hours by rail being required



Middle Section of Rokko-goe-Arima Cable Line, showing Midway Station, Shimizu



Declivity along Mid-Section of 1,200 meter Nikko Funicular Railway, Operation of which began August 28, 1932

to reach it, whereas the latter is easily accessible from Osaka in 30 minutes by tram.

Shigi-Ikoma Line

3. *Shigi-san Funicular Railway.*—Operated by Shigi-Ikoma Electric Railway Company at Misato-mura, Ikoma-gun, Nara Prefecture.

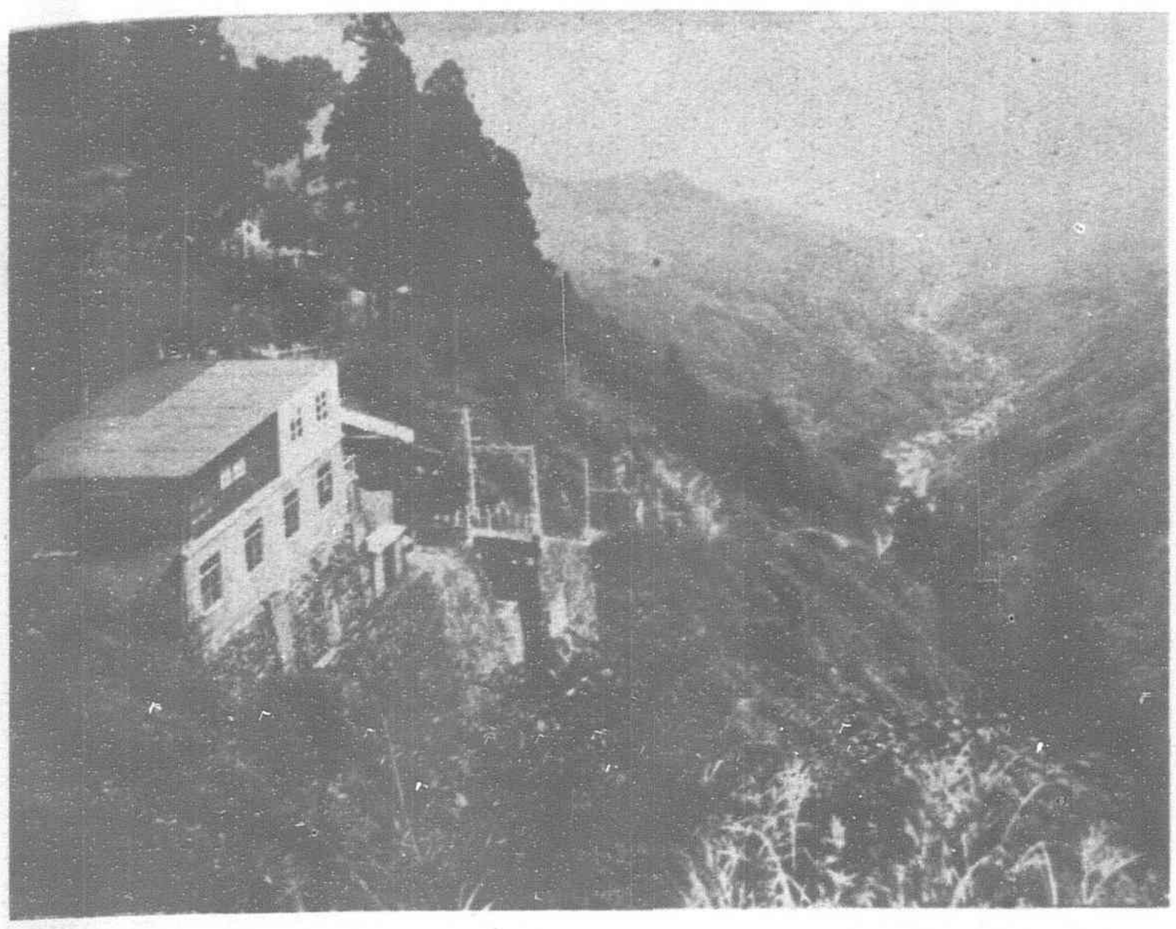
Date of opening ..	May 16, 1922
Length of line ..	1.1 mile
Difference of altitude between terminal stations	745.08 feet
Traction cable :	
Diameter	27 mm.
Type	Hercules rope : 6 strands of 19 wires with hemp core.
Weight	3.58 kg/m.
Breaking strength ..	49,000 kg.
Electric drive (Japan Elevator) :	
Voltage	550-volts D.C.
Motor develops ..	125 h.p.
Diameter of 2-groove main sheave ..	3,657 mm.
Cars :	
Weight each ..	8,150 kg.
Capacity	56 persons
Construction cost ..	Y.2,410,704*
Running time ..	11 minutes
One way fare ..	30 sen

*Includes cost of surface line.

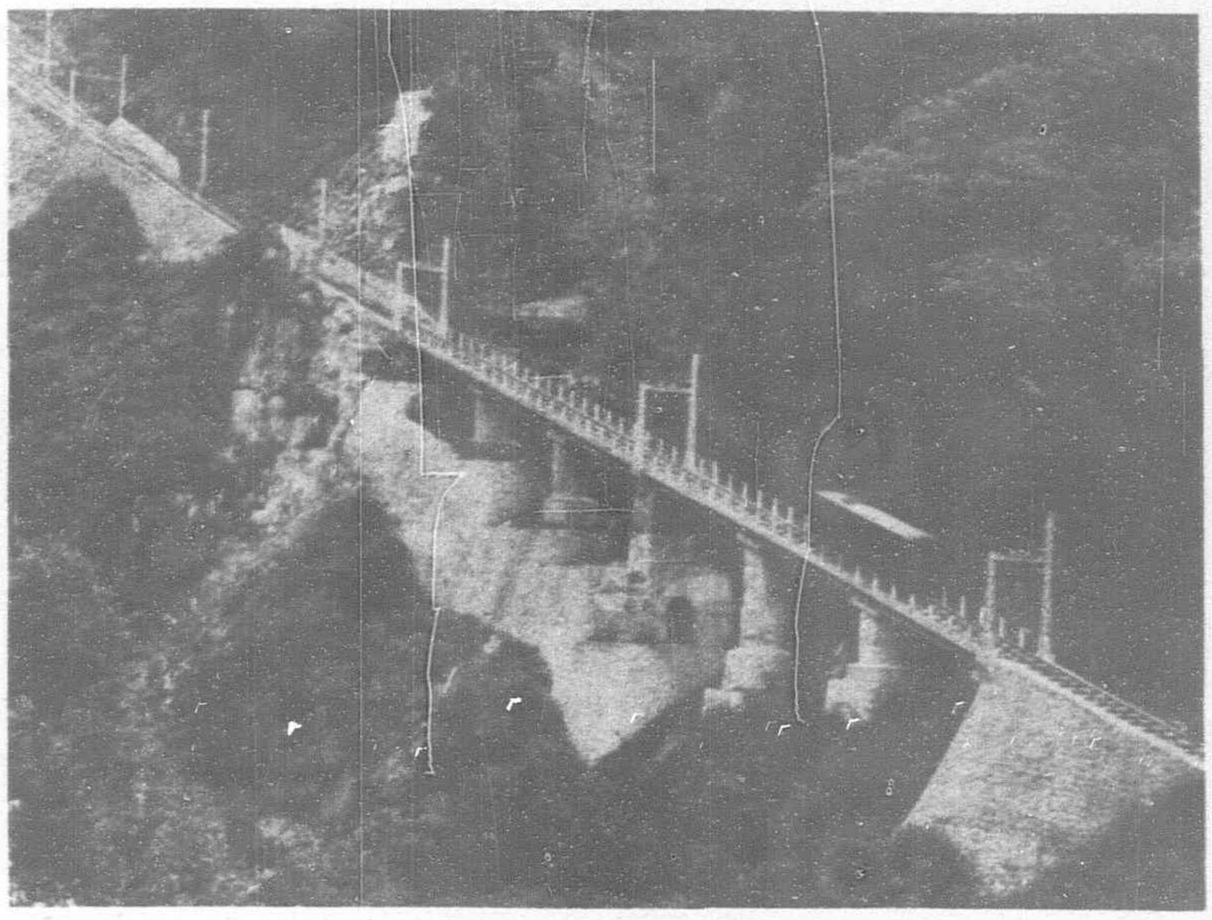
Part of Lower Section of Oyama Funicular Railway

The Shigi-Ikoma Funicular Line is 500 to 1,300 feet above sea level, half way up Mt. Shigi (alt. 1,703-ft.) in the southern extremity of the Ikoma range, which is connected by tram with Oji Station on the Kwansai Main Line (Nagoya—Minato-machi) of the Government Railways. About three miles East of Yamashita Station, the eastern terminus of the cable line, is the Tatsuta-gawa, a river in Yamato Province, associated with classical Japanese poetry on account of the presence of many maple-trees, whose glowing crimson in autumn has been from early ages the delight of poets. A few minutes' walk westward from Shigi-san Station, the terminus of the cable line, brings one to the famous Somu-ji (Buddhist temple), dedicated to the god, Bishamon-ten. According to tradition, Kusunoki Masashige, a patriot of the 14th century, who is looked upon as a high model of loyal service in Japanese history, was born in consequence of prayers to the god, so that he was called, while young, Tamon-maru, another name for Bishamonten. The deity, regarded in feudal days as the protector of fortune in war, has great numbers of followers in the Kinai and adjacent districts.

Visitors from Osaka, Nara, and their vicinity find it convenient to leave the train at Oji Station on the Kwansai Main Line, though it is less easily accessible than the Hozan-ji on Mt. Ikoma. The recent extension of the Shigi-Ikoma Electric Railway, by which the cable line is maintained, up



Looking down at Distant Housetops of Oyama from Summit Terminus of Oyama Cable Line



Sectional view of 739 meter Oyama Funicular Railway from Oiwake (Altitude 395 meters) to Shimoyashiro (675 meters) with Cable Car in motion. Opened August 1, 1932

to Ikoma-machi, put both the precincts in direct connection, making it easier for visitors to see them on one trip.

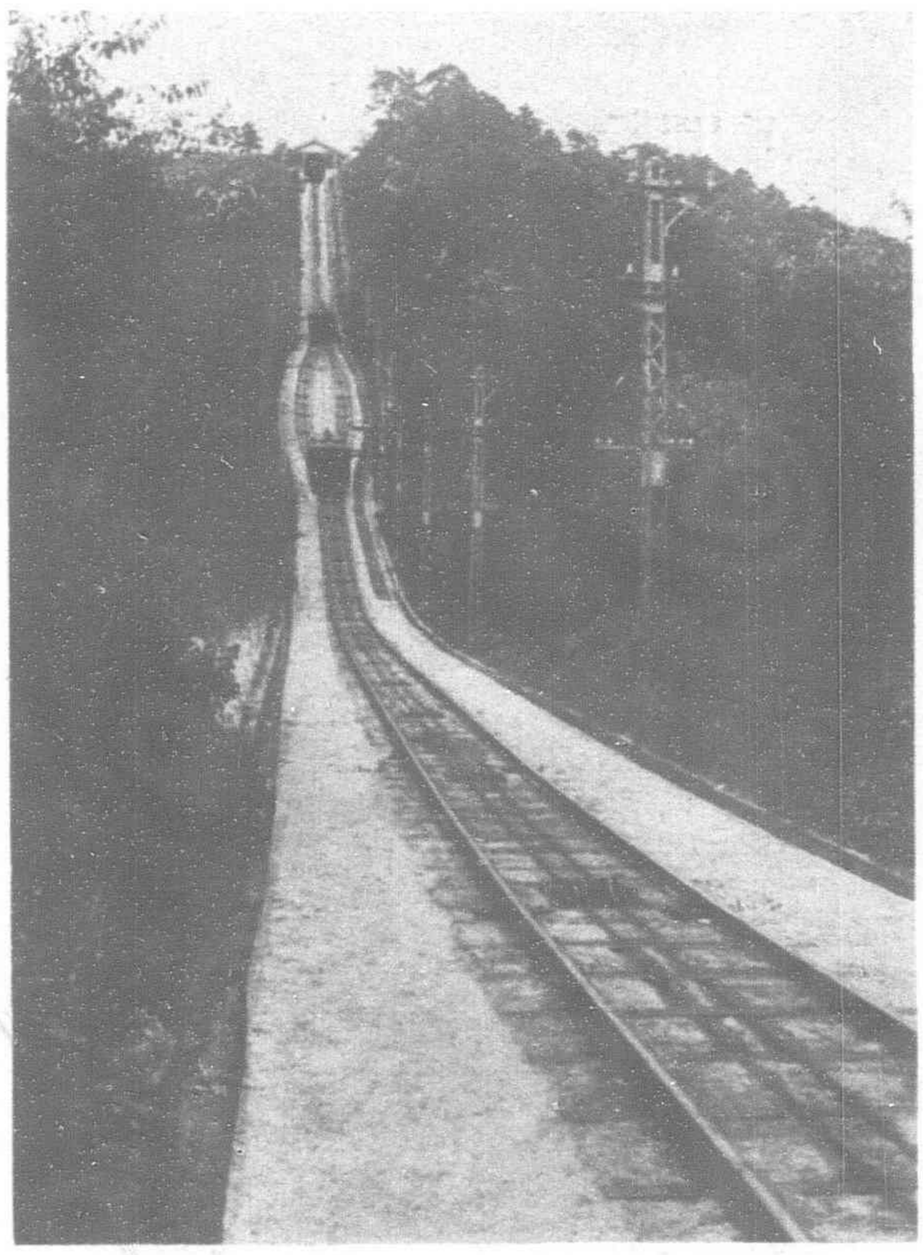
Maya-San Line

4. *Maya-san Funicular Railway.*—Operated by the Maya Funicular Railway Company at Nishinada-mura, Muko-gun, Hyogo Prefecture.

Date of opening	January 6, 1924
Length of line	.6 mile
Difference of altitude between terminal stations	1,025.05 feet
Traction cable :	
Diameter	30 mm.
Type	Hercules rope : 6 strands of 22 wires with hemp core.
Weight	3.78 kg/m.
Breaking strength	69.500 kg.
Electric drive (Theodore Bell) :	
Voltage	220 A.C.
Motor develops ..	100 h.p.
Diameter of 4-groove main sheave ..	3,200 mm.
Cars :	
Weight each ..	6,000 kg.
Capacity ..	62 persons
Construction cost..	Y.686,369
Running time ..	6 minutes
One way fare ..	25 sen

Maya-san, alt. 2,305-ft., one of the highest mountains behind Kobe, on which is an ancient temple, Tori-Tenjo-ji, dedicated to Maya Fuji, the mother of Buddha, attracts a constant stream of worshippers and sighteseers. The precincts, approached by 284 stone steps, command a splendid panoramic view of Kii Channel and Awaji Island over the city of Kobe, which has a population of nearly 800,000. The citizens repair to this height to enjoy the bracing air in summer or the moonlight in autumn. The Maya cable railway, constructed on this mountain side, runs more than halfway to the temple, which is about one-half mile from the terminus. Thus the line accommodates visitors, who were very numerous even before the cable line was built. The railway is laid in a favorably situated geographic spot, having Kobe within easy reach, though the only connection between the Kobe tram-car stop at Kami-tsutsui and the cable line is by means of motor-cars running between the two places.

The Tori-Tenjo-ji temple stands at a short distance from the terminus and is reached by a zigzag path. The summit lies more than 1,000 feet above the temple. The difference of temperature at the upper and lower termini is said to be as much as 10 degrees.

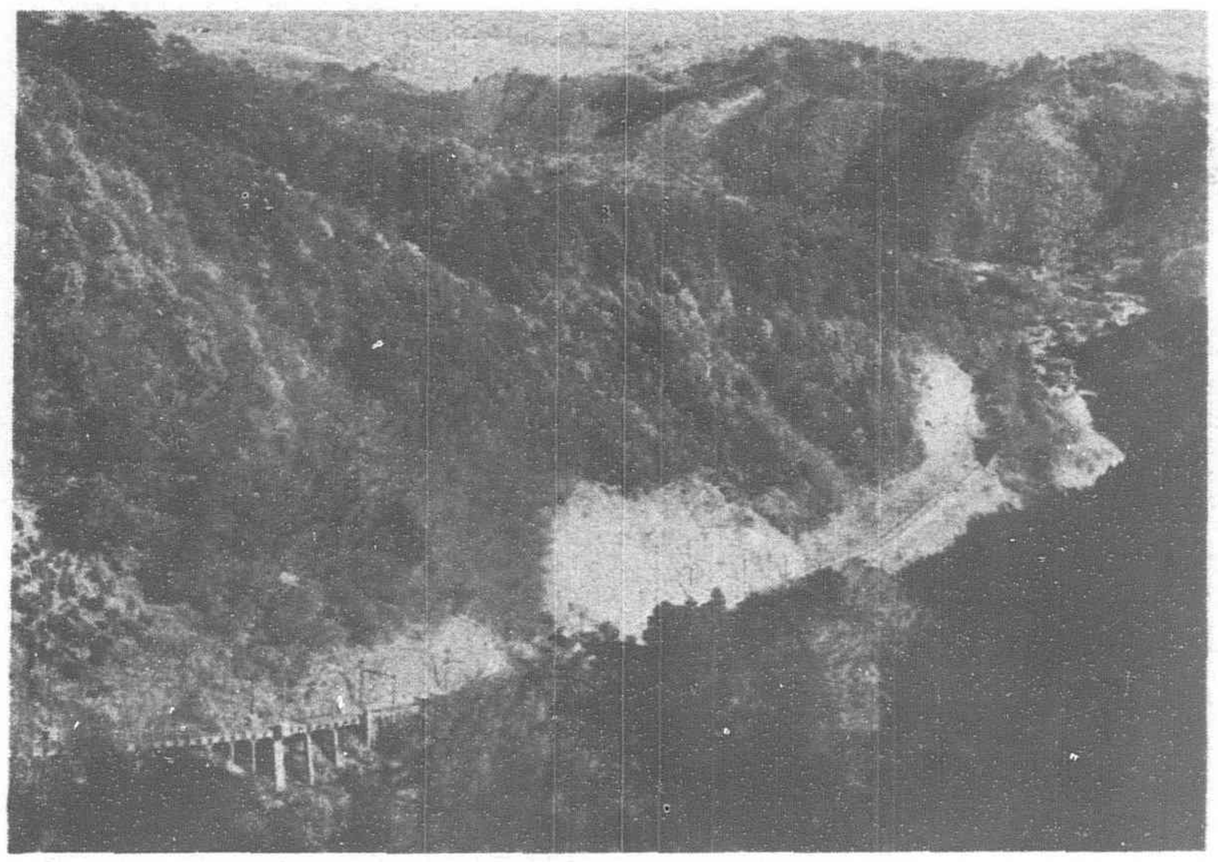


Looking up length of .2 mile Ama-no-Hashidate Funicular Railway, extending from 48.2-foot to 426.4-foot Altitude. Opened August 13, 1927

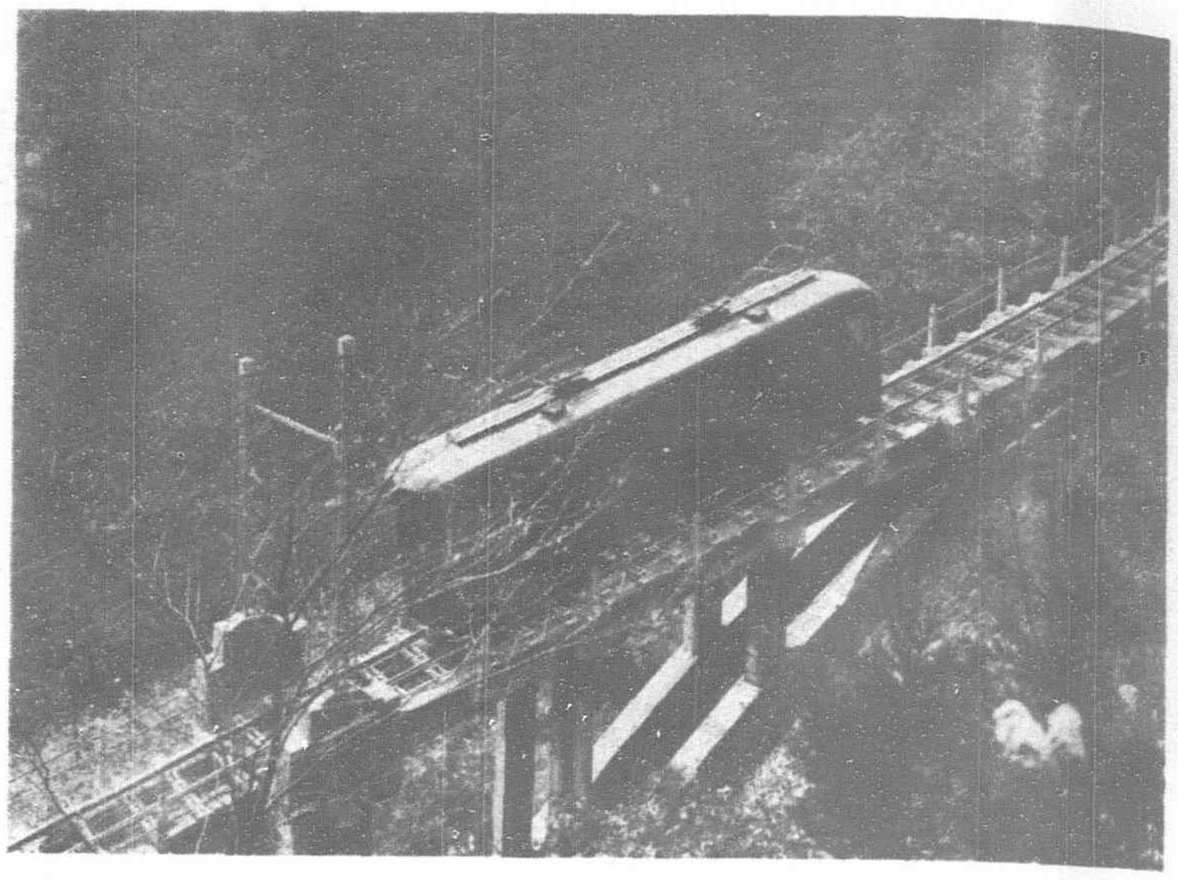
Myoken-San Line

5. *Myoken-san Funicular Railway.*—Operated by the Myoken Funicular Railway Company at Higashitani-mura, Kawanobe-gun, Hyogo Prefecture.

Date of opening	August 1, 1925
Length of line ..	.9 mile
Difference of altitude between terminal stations ..	1,175.7 feet
Traction cables :	
Diameters ..	26 mm. and 33 mm.
Type	Hercules ropes: each 6 strands of 17 wires with hemp core.
Weights	2.26 kg/m. and 3.71 kg/m.
Breaking strength	36,800 kg. and 61,200 kg.
Electric drive (Theodore Bell) :	
Voltage	440 A.C.
Motors develop ..	100 h.p. each
Diameters of 4-groove and 3-groove main sheave respectively ..	3,200 mm. and 3,586 mm.
Cars :	
Weight each ..	6,250 kg.
Capacity ..	64 persons
Construction cost..	Y.637,679
Running time ..	10 minutes
One way fare ..	30 sen



Bird's Eye view of Lower Stretch of .6 mile Takao-san Funicular Railway, extending from 292-foot to 1,190-foot Altitude. Opened January 21, 1927



Car being drawn up incline along Upper Portion of Takao-san Cable Line, showing Sturdy Concrete Sub-Structure supporting the Track Bed

Mt. Myoken, 2,137-ft., lies in Toyono County of Settsu Province and is noted for a Buddhist temple on its summit. The temple is dedicated to its founder Nose-no-Myoken (Sudrsti), known from ancient times as the God of War or Good Luck. It is the head temple of Hokushin—(Polar Star, which is believed to be the substance of Myoken) Myoken and the center of pilgrimage from all parts of the Empire.

The temple can be reached from Kyoto, Osaka, or Kobe, each lying at a distance of from 20 to 22½ miles. Formerly Kameoka on the San-in Main Line was the entrance from Kyoto. Now that the Takarazuka line of the Hanshin (Osaka and Kobe) Express Electric Railway and the Nose Electric Railway meet at Ikeda, whence the latter proceeds towards Mt. Myoken, there are scarcely any passengers who take the Kameoka route. Ikeda, a town noted for sake brewing, is the entrance from Osaka and Kobe. On the way from Ikeda is the site of the Tada-no-Soen, a manor owned by Tada-no-Michinaka, the ancestor of the famous Minamoto clan. The source of Hirano mineral water is also found near here. The cable line begins at Takidani, a short way up from Myoken station, terminus of the Nose Electric Railway.

The railway consists of two sections which are connected at a certain spot where one must change cars. It was so built owing to both natural features and advantages of construction. On the summit there are no residences except those of priests. Below runs the clear stream of the Inagawa, and a waterfall is found in the mountain. Besides these two features, there is hardly any attractive scenery. Historically, however, the place is connected with those ancient devotees of the god, such as Tada-no. Michinaka, who lived at Tada in the Tenroku Era (970-973). Yamanaka Shikanosuke, one of the noted 10 warriors of Amako-uji, a powerful family in Izumo Province in the 16th century, and the well-known wrestler Inagawa in a popular ballad-drama. These associations attract about 1,000 passengers daily. Both the Nose Electric Railway and the Hanshin Express Railway are naturally patronized by pilgrims, just as the Osaka Electric Tramway Line owes its prosperity to the Ikoma temple.

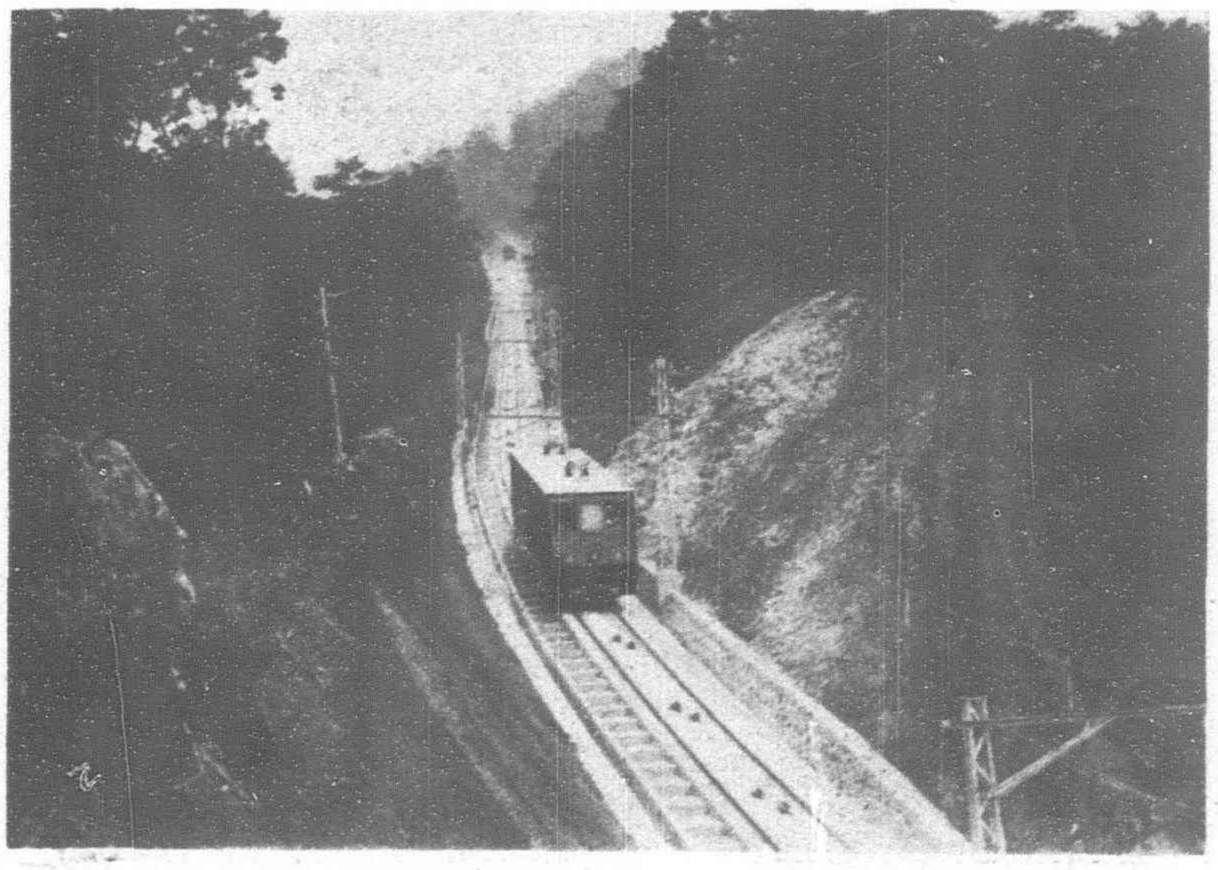
Asama-Yama Line

6. *Asama-yama Funicular Railway.*—Operated by the Mie Godo Electric Railway Company at Shigo-mura, Watarai-gun, Mie Prefecture.

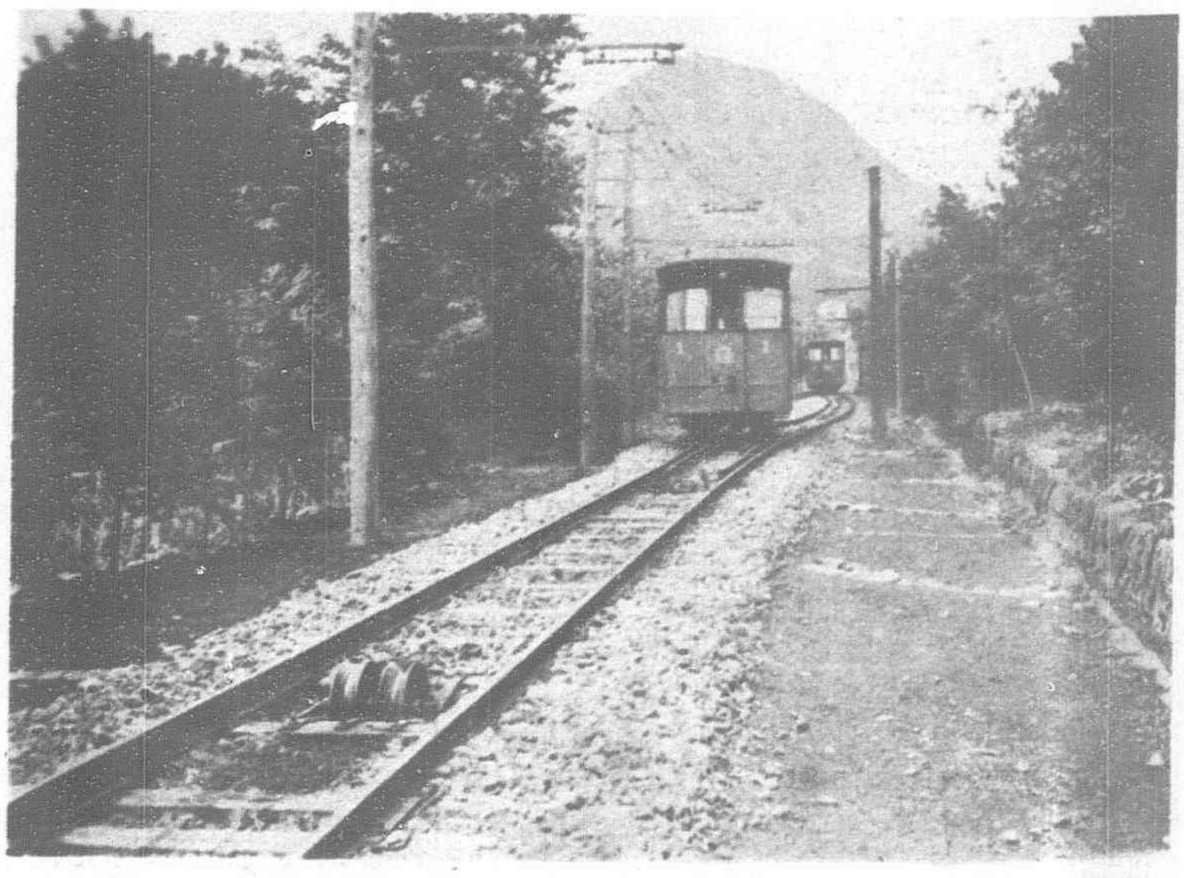
Date of opening	August 26, 1925
Length of line	.7 mile
Difference of altitude between terminal stations	1,270 feet

Traction cable :

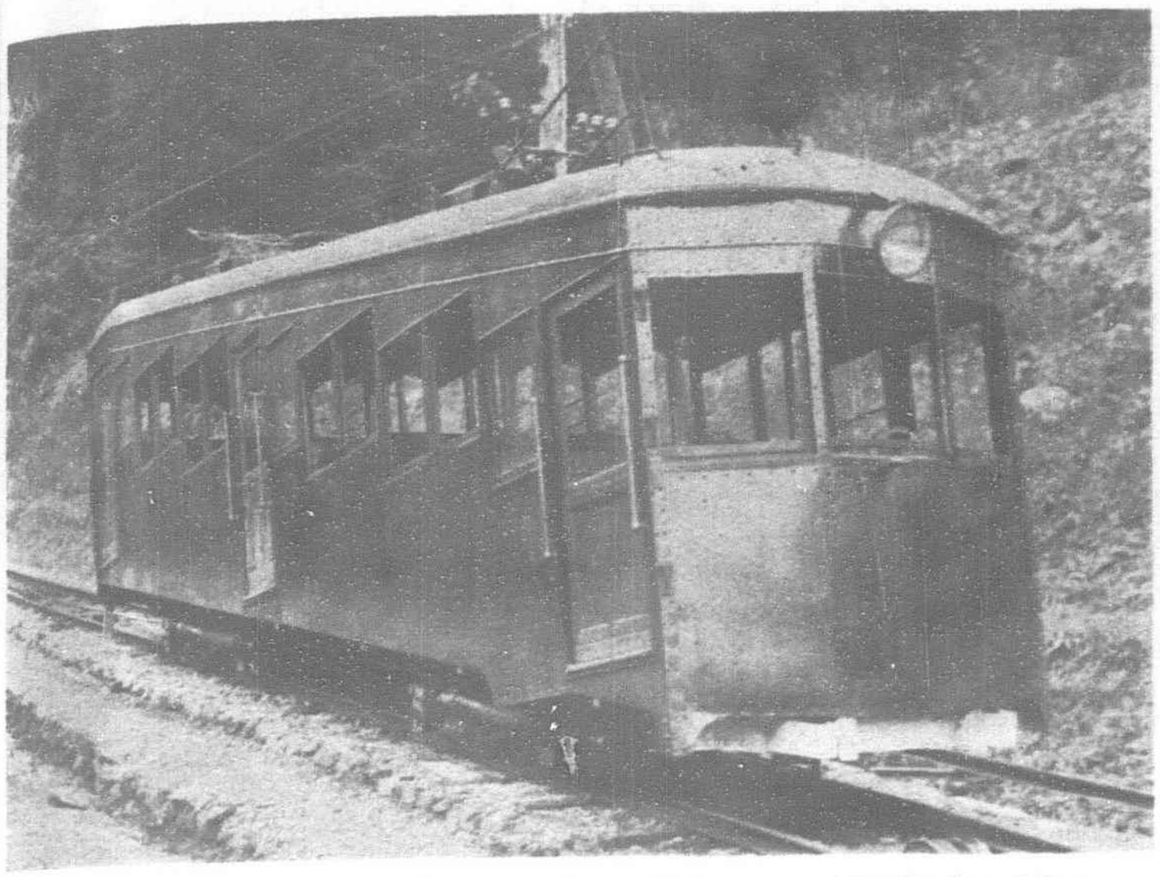
Diameter	31.2 mm.
Type	Hercules rope : 6 strands of 17 wires with hemp core.
Weight	3.21 kg/m.
Breaking strength	59,700 kg.



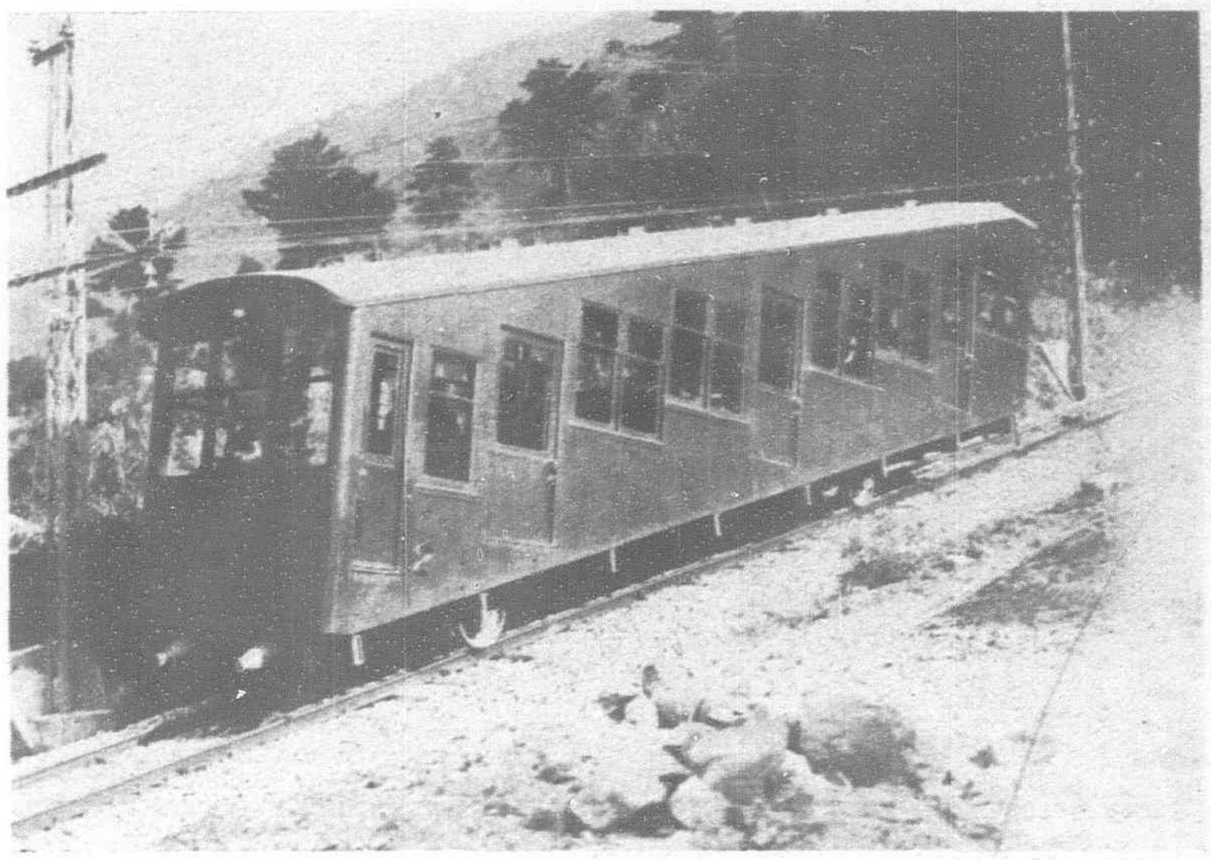
View of Ascent on Nikko Funicular Line from Umagayeshi (Altitude 842 meters) to Akechidaira (1,269 meters), with Portal of Tunnel in distant background



View along Mid-Section of .8 mile Hakone-yama Gora Park (Altitude 814.4 feet) Funicular Line to Summit of Soun-zan (2,519.8 feet). Opened December 1, 1921



Close-Up of one of the Cars used on Takao-san Funicular Line



Steel Constructed Cable Car ascending acclivity of Shiki-san Kyuko Funicular Railway

Electric drive (Theodore Bell) :

Voltage	220-volts A.C.
Motor develops	110 h.p.
Diameter of 3-groove main sheave	3,200 mm.

Cars :

Weight each	6,000 kg.
Capacity	40 persons
Construction cost	Y.1,295,124*
Running time	10 minutes
One way fare	23 sen

*Includes cost of surface line.

It is noteworthy that five cable lines were opened in 1925, one of which was the Asama-yama Funicular Railway. This line was built principally for pilgrims to Ise Daijingu, the Great Shrines of Ise, who number annually 1,000,000. Asama-yama, 1,600 feet, stands north-east of Uji, where is the Inner Shrine, Naigu, of the Daijingu. It is between Uji and the port town of Toba, ranging with the holy hill named Kamiji-yama. The Isuzu-gawa winds its course along the foot of these hills, passing through the premises of Naigu. On the summit of Asama-yama is Kongosho-ji, a Buddhist temple, of which the chief image, Kokuzo, was carved by Kobo-Daishi. From the summit is obtained a wide panoramic view, including the picturesque Futami-ga-ura, a pretty beach covered by a pine grove, the Port of Toba and Ise Bay, not to mention the city of Uji-Yamada called Shinto or Capital of God. Every Japanese, it is thought, ought to make a pilgrimage to the Great Shrines at least once in his life, and he would not miss the chance to ascend Asama-yama on that occasion. This is the principal reason for the establishment of this line.

The cable line starts at Hiraiwa, though the surface line begins at Kusube, junction on the Mie Godo Electric Railway, which runs between Uji, Yamada and Futami-no-ura. The surface line of the funicular railway extends about 2½ miles, and the cable line ascends to 1,370 feet. The railway is patronized by pilgrims from all over the Empire, as well as by the citizens of Uji-Yamada which has a population of about 50,000.

Tsukuba-San Line

7. *Tsukuba-san Funicular Railway.*—Operated by the Tsukuba-san Funicular Railway Company at Tsukuba-machi, Tsukuba-gun, Ibaraki Prefecture.

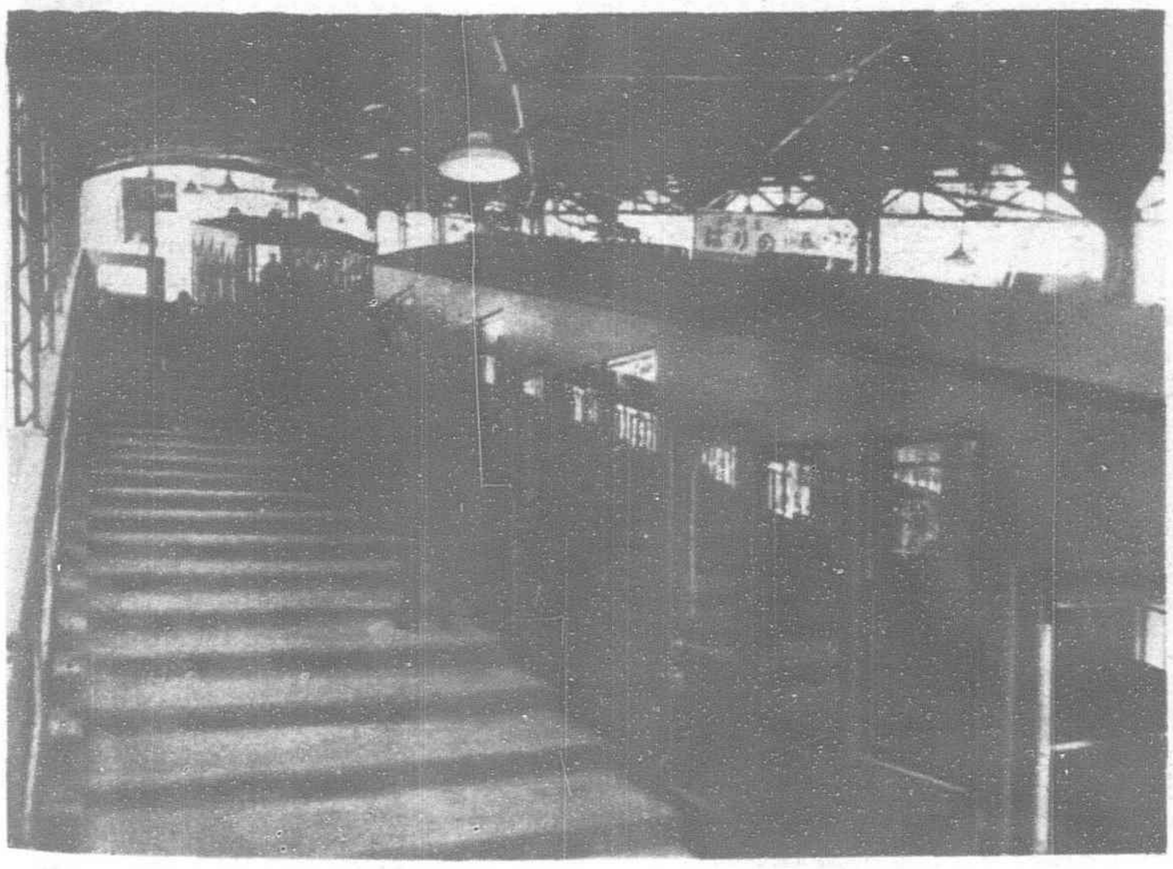
Date of opening	October 12, 1925
Length of line	1 mile
Difference of altitude between terminal stations	1,776 feet

Traction cable :

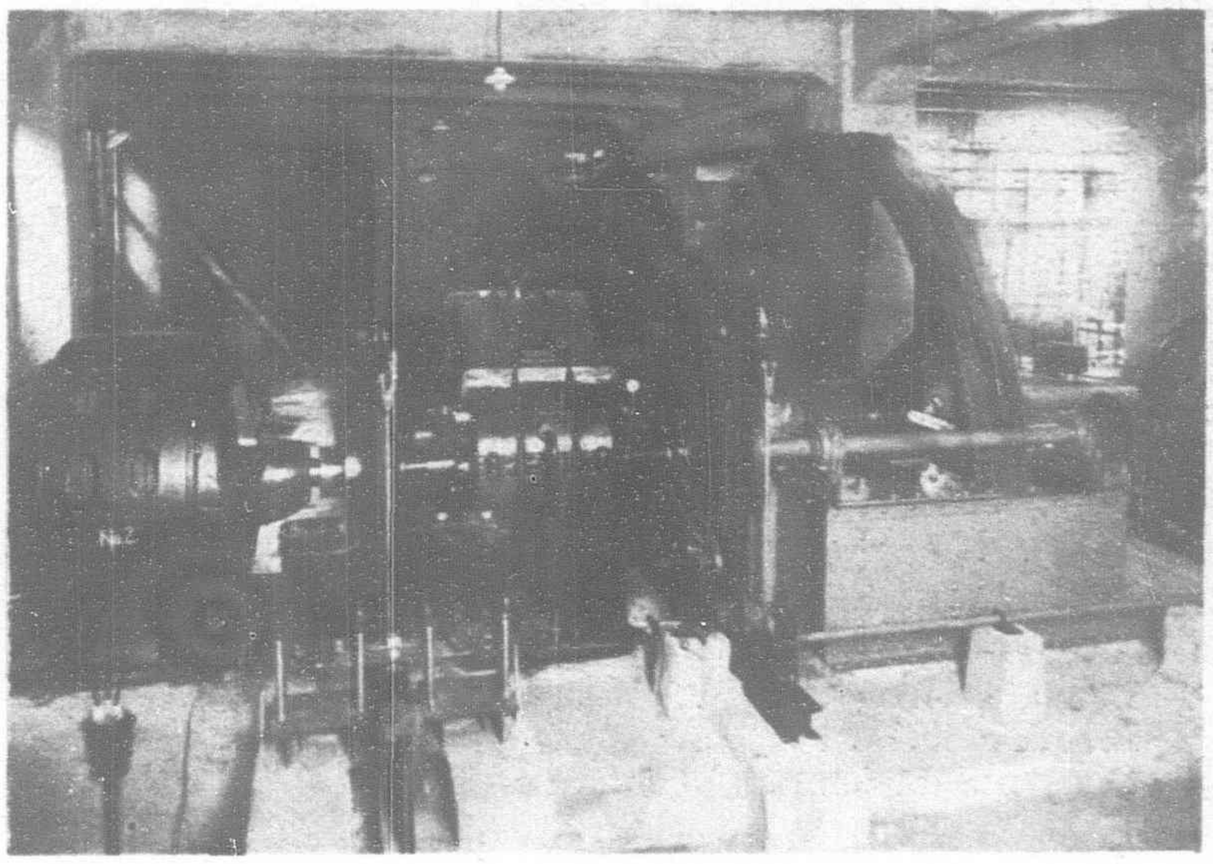
Diameter	31.1 mm.
Type	Hercules rope : 6 strands of 17 wires with hemp core.
Weight	3.21 kg/m.
Breaking strength	54,700 kg.

Electric drive (Theodore Bell) :

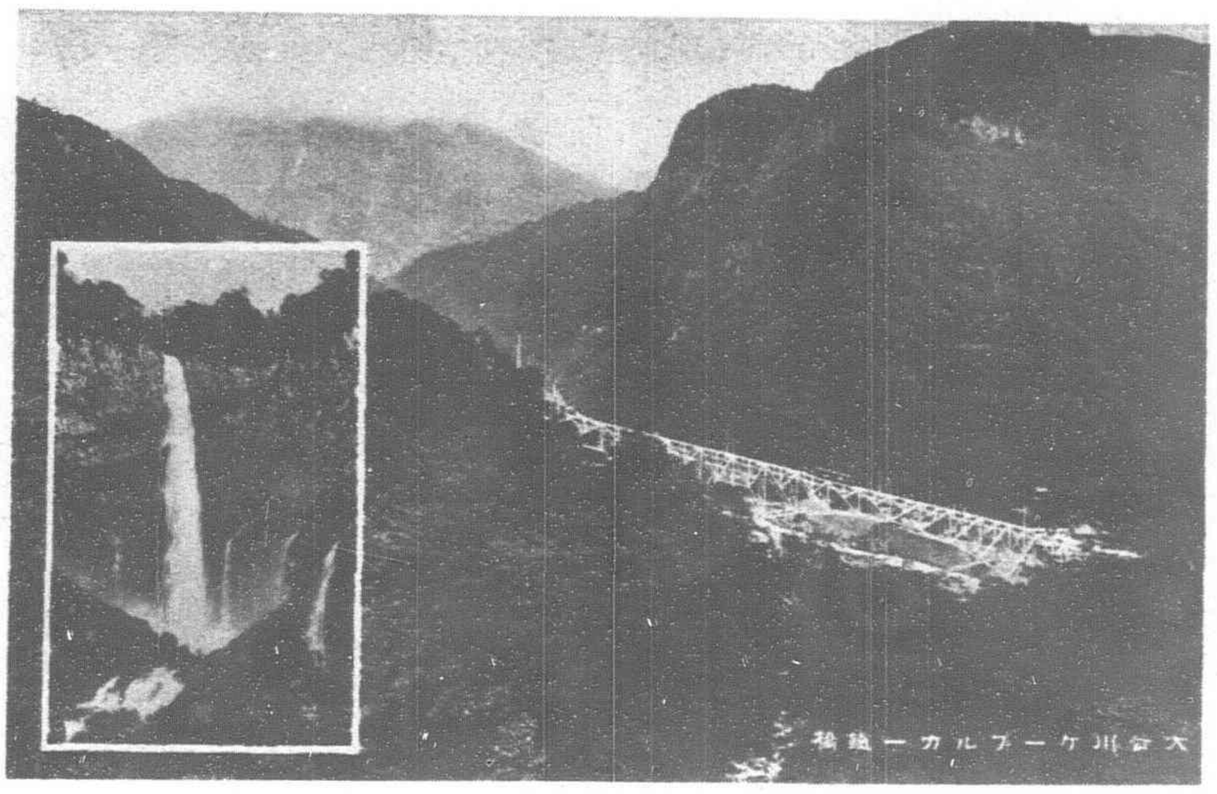
Voltage	440-volts A.C.
Motor develops	110 h.p.
Diameter of 3-groove main sheave	3,200 mm.



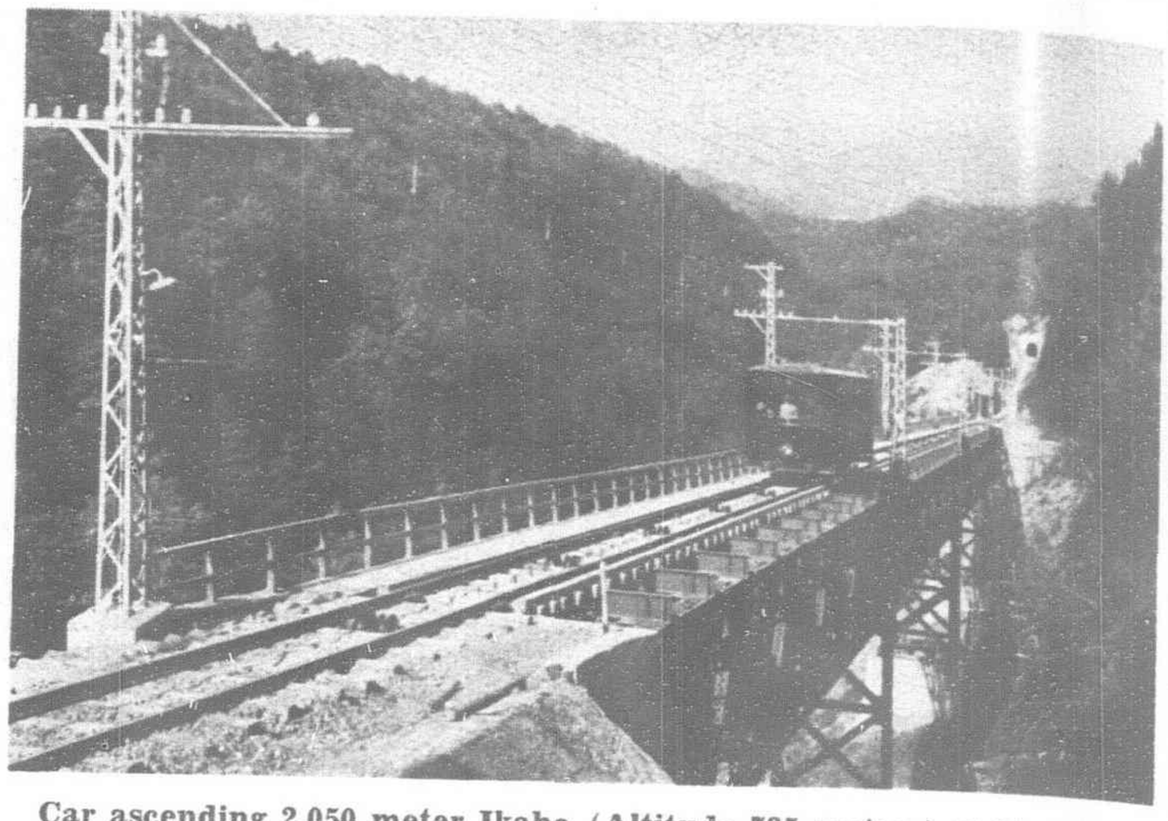
Platform and Cable Cars at Shimizu Midway Station on Rokko-goe-Arima Funicular Line



Cable Winding Machinery and Motor Equipment Installed in Driving Room of Rokko-goe-Arima Funicular Railway



Long Steel Trestlework in depression between two mountains along course of Nikko Cable Line. Inset: View of World Famous Kegon Waterfall near Chuzenji Lake above Nikko



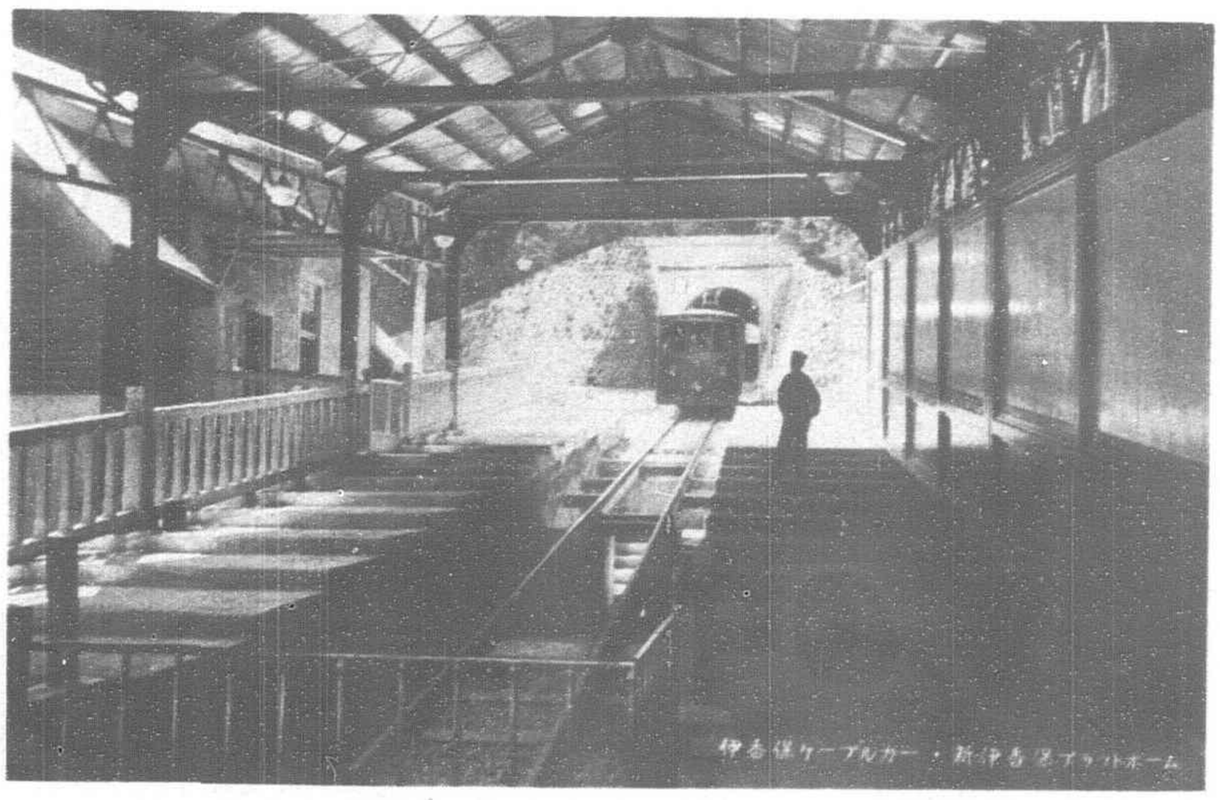
Car ascending 2,050 meter Ikaho (Altitude 735 meters) Cable Line to Summit of Haruna-yama (1,178 meters). Opened September 6, 1929

Cars :

Weight each	5,800 kg.
Capacity	No. 1, 64 ; No. 2, 52
Construction cost	Y.575,396
Running time	9 minutes
One way fare	45 sen

At a distance of about 50 miles from Tokyo there are two noted mountains ; one is Hakone lying in the south-west and the other, Tsukuba-san in the north-east. Each has a modest elevation of about 3,000 feet, lying within easy access from Tokyo by rail.

Mt. Tsukuba is an isolated peak on the wide plain of Kwanto, and can be seen from nearly every part of the district. The summit commands a far extended view and is celebrated for its scenic beauty. Kasumi-ga-ura, one of the largest lagoons in Japan, lies at the foot of the mountain. The Shinto Shrine of Tsukuba stands about half-way up, and on top is found the meteorological observatory originally established by the late Prince Yamashina. The peak is connected with some personages, such as the Saint Honen-Shonin, Takeda Kounsai and Fujita Koshiro. The latter two were noted patriots at the time of the Restoration, who raised their banner on this peak in the cause of the Emperor and the expulsion of foreigners. There at the foot stands the site of Oda Castle, in which Kitabatake Chikafusa, the renowned loyalist, wrote the famous book named "Jinnoseitoki" (Record of the Legitimate Imperial Line).



Lower Terminus of Ikaho Funicular Railway

Mt. Tsukuba is a place of interest for a one-day trip for the people of Tokyo and Yokohama. In view of this attraction, the Tsukuba Funicular Railway was constructed from the town of Tsukuba to the summit. It takes about four hours from Tokyo to the summit.

Hiei-Zan Line

8. *Hiei-zan Funicular Railway* (on Kyoto side).—Operated by the Kyoto Electric Light Company at Shugakuin-mura, Otagi-gun, Kyoto Prefecture.

Date of opening	December 20, 1925
Length of line	.8 mile
Difference of altitude between terminal stations	1,839 feet

Traction cable :

Diameter	35 mm.
Type	Hercules rope : 6 strands of 17 wires with hemp core.
Weight	5.28 kg/m.
Breaking strength	88,000 kg.

Electric drive (Theodore Bell) :

Voltage	3,300-volts A.C.
Motor develops	190 h.p.
Diameter of 3-groove main sheave	3,800 mm.

Cars :

Weight each	9,500 kg.
Capacity	100 persons
Construction cost	Y.4,310,022*
Running time	9 minutes
One way fare	35 sen

*Includes cost of surface line.

Hiei-zan, 2,800 feet, stands to the north-east of Kyoto. It is famous on account of Enryaku-ji, a Buddhist temple of the Tendai sect, founded by Saicho Dengyo-Daishi about 1,100 years ago. The holy temple is the central object of pilgrimage of this country, but many other old buildings are found scattered on different peaks. At Toto is the Kompon-Chudo or Central Hall, and in in Saito and Yakawa are also located various buildings. Shimei-ga-dake, one of the mountain peaks, is noted for its connection with Taira-no-Masakado and Fujiwara-no-Sumitomo, joint traitors to the Imperial Court. The peaks afford splendid panoramic views including Kyoto in the south-west and Lake Biwa in the east. After the founding of the capital at Kyoto, not only the citizens of the capital, but people from all over the country, paid homage to the temple and enjoyed the scenery.

The usual way of reaching Hiei-zan is by one of two paths, that leading from the Kyoto side being called Shirakawa-guchi and the other from the Omi side, Sakamoto-guchi. Each of these two points has a cable car line.

Otoko-Yama Line

9. *Otoko-yama Funicular Railway.*—Operated by the Otoko-yama Railway Company at Yawata-machi, Tsuzuki-gun, Kyoto Prefecture.

Date of opening	June 22, 1926
Length of line	.3 mile

Difference of altitude between terminal stations	26.7 feet
Traction cable :	
Diameter	26 mm.
Type	Hercules rope : 6 strands of 16 wires with hemp core.
Breaking strength	48,000 kg.
Electric drive (Hitachi) :	
Voltage	3,300-volts A.C.
Motor develops	75 h.p.
Diameter of 4-groove main sheave.	3,048 mm.
Cars :	
Weight each	6,000 kg.
Capacity	50 persons
Construction cost	Y.486,270
Running time	4½ minutes
One way fare	15 sen

The Yodo-gawa running down from the basin of Kyoto towards Settsu and Kawachi provinces meets the mountain ranges at Yamazaki and makes a noted pass, whence it enters the plains of both provinces. The Yamazaki Pass consitutes, as it were, the south Barrier-gate of Kyoto ; in the south towers Hatoga-mine, 442 feet, the highest point of Otoko-yama on the northern extremity of the Ikoma mountain range, and in the north stands Tenno-zan, directly in front of Yamazaki station on the Tokaido Main Line. Here at Yamazaki crosses the Saikoku (Western provinces) and Kawachi highways, and there along the river passes the Keihan (Kyoto and Osaka) and the Shin (new)-Keihan Electric Railways besides the Tokaido Main Line. It was and is an important pass. Yamazaki is also historically famous. It was here at the Iwashimizu Hachiman-gu or Otoko-yama Hachiman-gu, a Government shrine on Hatoga-mine, that the former Emperor Kameyama prayed one night to the gods enshrined for the protection of the Empire, to take his life, if necessary, when the Mongols invaded Japan in 1281. Tenno-zan is famous in connection with the Battle of Yamazaki between Toyotomi Hideyoshi and Akechi Mitsuhide, the speedy occupation of the hill by the former's forces deciding the dictatorship of the Empire.

Otoko-yama Funicular Railway was constructed for the pilgrims to the Hachiman Shrine, and is connected with the Keihan Electric Railway at Yawata station. Its length and the difference of altitude of the terminal stations are about one-third of those of other railways of its kind, but the number of passengers is much more than was originally expected.

Takao-San Line

10. *Takao-san Funicular Railway.*—Operated by the Takaotozan Railway Company at Asakawa-mura, Minami-Tama-gun, Tokyo County.

Date of opening	January 21, 1927
Length of line	.6 mile
Difference of altitude between terminal stations	898.1 feet
Traction cable :	
Diameter	31.8 mm.
Type	Hercules rope : 6 strands of 7 wires with hemp core.
Weight	3.88 kg/m.
Breaking strength	76,000 kg.
Electric drive (Japan Elevator) :	
Voltage	3,300-volts A.C.
Motor develops	200 h.p.
Diameter of 4-groove main sheave	3,657 mm.
Cars :	
Weight each	6,700 kg.
Capacity	50 persons
Construction cost	Y.768,944
Running time	7 minutes
One way fare	25 sen

Mt. Takao, 27 miles from Tokyo, rises on the western extremity of the Musashino Plain. Near the summit, is the famous temple Yakuoin, which, being dedicated to the god Fudo Myoo, belongs to the Chizan branch of the Shingon sect. The place is also famous for the gay autumnal tints of maple trees and some beautiful cascades. From the summit one can enjoy a broad view of the Kwanto Plain, which extends in a north-easterly direction. Just beyond the Sagami River the graceful figure of Mt. Fuji may be seen, and Kobotoke Pass is reached from the back of the mountain. These favorable conditions made this mountain an excellent ground for training the citizens of Tokyo and Yokohama in the actual knowledge and interests of mountain climbing. It became more popular after the Mausoleum of the Emperor Taisho (Musashi-Tama Mausoleum) was built at the end of 1927 at the Asakawa village, only about 2½ miles away. The Takao Funicular Railway was built on this mountain side at a distance of about two miles from Asakawa Station on the Chuo Line.

Hiei-Zan Line (Otsu Side)

11. *Hiei-zan Funicular Railway* (on Otsu side).—Operated by the Hiei-zan Funicular Railway Company at Sakamoto-mura, Shiga-gun, Shiga Prefecture.

Date of opening	March 15, 1927
Length of line	1.2 mile
Difference of altitude between terminal stations	1,597.42 feet
Traction cable :	
Diameter	35 mm.
Type	Hercules rope : 6 strands of 17 wires with hemp core.
Weight	4.91 kg/m.
Breaking strength	71,300 kg.
Electric drive (Theodore Bell) :	
Voltage	3,300-volts A.C.
Motor develops	150 h.p.
Diameter of 3-groove main sheave	3,830 mm.
Cars :	
Weight each	9,000 kg.
Capacity	84 persons
Construction cost	Y.1,030,241
Running time	11 minutes
Fare	Up, 45 sen ; down, 40 sen

As already mentioned, Mt. Hiei has been famous as a mountain that guards Kyoto, the old Imperial Metropolis, especially since Saint Dengyo-Daishi founded the Enryaku-ji, which belongs to the Tendai sect of Buddhism. The Hiei-zan Funicular Railway was constructed along the Sakamoto-guchi path on the east side of the mountain, and a similar line runs along the Shirakawa-guchi path on the west side. At the foot of the Sakamoto path, there is the famous Hiyoshi Shrine, a grand Government Shrine. From the cable car is obtained a fine view of Lake Biwa with its eight places of scenic beauty around the shore. All the interesting points on the southern shore of Lake Biwa are within easy reach.

In the matter of unique scenery which is spread in a panorama before the passengers, no other funicular railways can compare with this line. This naturally favored the traffic from its beginning so much that 1,050 people use this line on a daily average, the percentage of profit against construction cost being 7.4 per cent.

Ama-No-Hashidate Line

12. *Ama-no-Hashidate Funicular Railway.*—Operated by the Ama-no-Hashidate Funicular Railway Company at Fuchu-mura, Yosa-gun, Kyoto Prefecture.

Date of opening	August 13, 1927
Length of line	.2 mile
Difference of altitude between terminal stations	378.25 feet
Traction cable :	
Diameter	28.6 mm.
Type	Hercules rope : 6 strands of 7 wires with hemp core.
Weight	3.93 kg/m.
Breaking strength	55,600 kg.
Electric drive (Japan Elevator) :	
Voltage	220-volts A.C.
Motor develops	60 h.p.
Diameter of 4-groove main sheave	3,048 mm.

Cars :

Weight each	4,800 kg.
Capacity	24 persons
Construction cost..	Y.221,352
Running time	4 minutes
One way fare	20 sen

The Ama-no-Hashidate Funicular Railway commands to the South a view of Ama-no-Hashidate or Heavenly Bridge, popularly known as one of the three scenic beauty spots of Japan, and the peaceful Inner Bay of Yosa. Mt. Nariai towers at the back, and the Nariai Temple, one of the 33 temples of Pilgrimage in the West provinces, which stands half-way up the mountain, claims to be the most beautiful and sacred spot on tne Japan Sea Coast. The only unfortunate thing for the railway is that, as the place is located unfavorably, far from any large cities, it is visited by a comparatively small number of sightseers and pilgrims.

Chugoku Inari Line

13. *Chugoku Inari-yama Funicular Railway.*—This line, operated by the Chugoku Inari-yama Cable Car Railway Company, is near the terminal station of the Inari branch of the Chugoku Railroad, Okayama Prefecture. It was constructed for the benefit of pilgrims to Inari-san. Principal details concerning the line are :

Date operation was begun ..	February 9, 1929
Length of line	400 meters
Difference of altitude between two stations	167 meters
Track gauge	1.067 meter
Traction cable :	
Diameter	30 mm.
Type	Hercules rope : 6 strands of 17 wires with hemp core.
Weight	3.69 kg/m.
Breaking strength	45 tons
Driving machinery (Electric) :	
Voltage	3,300-volts A.C.
Capacity	45 kw.
Diameter of main sheave ..	3,100 mm.
Cars :	
Weight each	6 tons
Capacity	50 persons
Construction cost	Y.160,470

Yashima Line

14. *Yashima Funicular Railway.*—Operated by the Yashima-tozan Railway Company, this funicular line is on the south slope of Mt. Yashima at the site of the well-known battlefield of *Gempei* near Takamatsu, Kagawa Prefecture. Built primarily as a scenic railway, its chief features are :

Date operation was begun ..	April 4, 1929
Length of line	800 meters
Difference of altitude between two stations	265 meters
Track gauge	1.067 meter
Traction cable :	
Diameter	33 mm.
Type	Hercules rope : 6 strands of 24 wires with hemp core.
Weight	4.72 kg/m.
Breaking strength	63.5 tons
Driving machinery (Electric) :	
Voltage	3,300-volts A.C.
Capacity	112 kw.
Diameter of main sheave ..	3,300 mm.
Cars :	
Weight each	10 tons
Capacity	64 persons
Construction cost	Y.383,000

Atago-Yama Line

15. *Atago-yama Funicular Railway.*—This cable line, operated by the Atago-yama Railway Company starts from Kiyotaki-gawa near Mt. Arashi, Kyoto County. It was constructed for pilgrims to Akiba Shrine, which is situated on the summit of Atago-yama, and for the benefit of sightseers. Its principal features are :

Date operation was begun ..	July 25, 1929
Length of line	2,040 meters
Difference of altitude between terminal stations	638 meters
Track gage	1.067 meter
Traction cable :	
Diameter	36 mm.
Type	Hercules rope : 6 strands of 24 wires with hemp core.
Weight	5.46 kg/m.
Breaking strength	83.37 tons
Driving machinery (Electric) :	
Voltage	3,300 volts a.c.
Capacity	150 kw.
Diameter of main sheave ..	3,400 mm.
Cars :	
Weight each	9 tons
Capacity	84 persons
Construction cost..	Y.1,140,052

Ikaho Line

16. *Ikaho Funicular Railway.*—Operated by the Kwanto Cable Railway Company, this line is at Ikaho, one of Japan's famous hot spring resorts. It was built to aid travellers planning a pleasure trip around Lake Haruna at the top of the mountain of the same name. Its outstanding features are :

Date operation was begun ..	September 6, 1929
Length of line	2,050 meters
Difference of altitude between terminal stations	443 meters
Track gauge	1.067 meter
Traction cable :	
Diameter	35 mm.
Type	Hercules rope : 6 strands of 17 wires with hemp core.
Weight	4.36 kg/m.
Breaking strength	66 tons
Driving machinery (Electric) :	
Voltage	3,300-volts A.C.
Capacity	100 kw
Diameter of main sheave ..	3,658 mm.
Cars :	
Weight each	10.5 tons
Capacity	80 persons
Construction cost..	Y.666,863

Beppu-Yuyen Line

17. *Beppu-yuyen Funicular Railway.*—This line, operated by the Beppu-yuyen Cable Car Railway Company, is at Beppu, a noted hot spring resort in Oita Prefecture, Kyushu. It was constructed primarily for the use of sightseers to the town of Beppu, and its chief features are :

Date operation was begun ..	September 21, 1929
Length of line	240 meters
Difference of altitude between two stations	121 meters
Track gauge	1.067 meter
Traction cable :	
Diameter	21 mm.
Type	Hercules rope : 6 strands of 6 wires with hemp core.
Weight	2 kg/m.
Breaking strength	32.4 tons
Driving machinery (Electric) :	
Voltage	3,300-volts A.C.
Capacity	24 kw.
Diameter of main sheave ..	2,100 mm.

Cars :

Weight each	4 tons
Capacity	22 persons
Construction cost	Y.154,136

Hashikura-Yama Line

18. *Hashikura-yama Funicular Railway.*—Operated by the Hashikura-tozan Railway Company, this cable line is at Hashikura-yama, Tokushima Prefecture. To accommodate the many pilgrims annually visiting the Kotohira Temple on the summit of Mt. Hashikura, this funicular railway was built. Its principal features are :

Date operation was begun	June 18, 1930
Length of line	470 meters
Difference of altitude between two stations	235 meters
Track gauge	1.067 meter
Traction cable :	
Diameter	30 mm.
Type	Hercules rope : 6 strands of 7 wires with hemp core.
Weight	4.72 kg/m.
Breaking strength	75 tons
Driving machinery (Electric) :	
Voltage	3,000-volts A.C.
Capacity	75 kw.
Diameter of main sheave	3,048 mm.
Cars :	
Weight each	6.5 tons
Capacity	40 persons
Construction cost	Y.280,929

Koya-San Line

19. *Koya-san Funicular Railway.*—This cable line, operated by the Koya-san Electric Railway Company, is at Mt. Koya, a celebrated Buddhist sanctuary. The sacred mountain, Koya-san, is in Wakayama Prefecture, and pilgrims who trek there in multitudes avail themselves of the funicular line. Its main features are :

Date operation was begun	June 29, 1930
Length of line	803 meters
Difference of altitude between two stations	329 meters
Track gauge	1.067 meter
Traction cable:	
Diameter	42 mm.
Type	Hercules rope : 6 strands of 24 wires with hemp core.
Weight	7.64 kg/m.
Breaking strength	114 tons
Driving machinery (Electric) :	
Voltage	3,300-volts A.C.
Capacity	210 kw.
Diameter of main sheave	4,200 mm.
Cars :	
Weight each	12.5 tons
Capacity	100 persons
Construction cost	Y.967,394

Shiki-San Line

20. *Shiki-san Funicular Railway.*—This cable line, operated by the Shiki-san Kyuko Railway Company, is situated at Takayasu-yama, Osaka County, on the west side of Mt. Shiki. It was constructed to accommodate pilgrims to Somuji (a famous Buddhist temple) as a short route from Osaka to the summit of Shiki-san. Its principal features are :

Date operation was begun	December 15, 1931
Length of line	1,300 meters
Difference of altitude between terminal stations	354 meters
Track gauge	1.067 meter
Traction cable :	
Diameter	42 mm.
Type	Hercules rope : 6 strands of 24 wires with hemp core.
Weight	7.64 kg/m.
Breaking strength	114 tons
Driving machinery (Electric) :	
Voltage	3,300-volts A.C.
Capacity	225 kw.
Diameter of main sheave	4,200 mm.
Cars :	
Weight each	10 tons
Capacity	100 persons
Construction cost	Y.757,170

Yakuri-San Line

21. *Yakuri-san Funicular Railway.*—This cable line, situated at Goken-zan near Yashima, Kagawa Prefecture, is operated by the Yakuri-tozan Railway Company. It was built for the convenience of pilgrims to Yakuri Temple on the summit of the mountain, and its chief features are :

Date operation was begun	February 15, 1931
Length of line	670 meters
Difference of altitude between two stations	158 meters
Track gauge	1.067 meter
Traction cable :	
Diameter	30 mm.
Type	Hercules rope : 6 strands of 24 wires with hemp core.
Weight	3.89 kg/m.
Breaking strength	59.8 tons
Driving machinery (Electric) :	
Voltage	3,000-volts A.C.
Capacity	75 kw.
Diameter of main sheave	3,200 mm.
Cars :	
Weight each	7 tons
Capacity	50 persons
Construction cost	Y.229,069

Rokko-San Line

22. *Rokko-san Funicular Railway.*—Situated on the south side of Mt. Rokko, this line is operated by the Rokko-goe-Arima Railway Company. Rokko-san is a popular highland resort not far from Kobe. It has excellent ski slopes, several ponds for skating in winter and a good 18-hole golf course. Outstanding features of this funicular railway, the first four-car system of its kind to be constructed in Japan, are :

Date operation was begun	March 10, 1932
Length of line	1,700 meters
Difference of altitude between terminal stations	493 meters
Track gauge	1.067 meter
Traction cable :	
Diameter	42 mm. and 28 mm.
Type	Hercules rope : 6 strands of 24 wires with hemp core.
Weight	7.64 kg/m.
Breaking strength	115 tons and 52 tons
Driving machinery (Electric) :	
Voltage	3,300-volts A.C.
Capacity	225 kw.
Diameter of main sheave	4,500 mm.
Cars :	
Weight each	9 tons
Capacity	80 persons
Construction cost	Y.1,400,000

Oyama Line

23. *Oyama Funicular Railway.*—This line, at Oyama, Kanagawa Prefecture, is operated by the Oyama Cable Car Railway

Company. It was built to accommodate pilgrims to Oyama Temple at the top of the mountain. Its main features are :

Date operation was begun ..	August 1, 1932
Length of line	739 meters
Difference of altitude between two stations	280 meters
Track gauge	1.067 meter
Traction cable :	
Diameter	38 mm.
Type	Hercules rope : 6 strands of 24 wires with hemp core.
Weight	5.36 kg/m.
Breaking strength	93.3 tons
Driving machinery (Electric) :	
Voltage	3,300-volts A.C.
Capacity	70 kw.
Diameter of main sheave ..	3,500 mm.
Cars :	
Weight each	8.5 tons
Capacity	56 persons
Construction cost	Y.609,780

24. *Nikko Funicular Railway.*—This cable line is near Lake Chuzenji at Nikko, which is world-famous in attracting visitors from far and wide. It is operated by the Nikko-tozan Railway Company, and its salient features are :

Date operation was begun ..	August 28, 1932
Length of line	1,200 meters
Difference of altitude between terminal stations	428 meters
Track gauge	1.067 meter
Traction cable :	
Diameter	35 mm.
Type	Hercules rope : 6 strands of 24 wires with hemp core.
Weight	5.32 kg/m.
Breaking strength	80 tons
Driving machinery (Electric) :	
Voltage	3,000-volts A.C.
Capacity	86 kw.
Diameter of main sheave ..	3,830 mm.
Cars :	
Weight each	8.5 tons
Capacity	80 persons
Construction cost	Y.750,000

The New Works of the Shanghai Gas Co.

(Continued from page 316)

The tar distilling plants are complete with steam dehydrators for the removal of water, overhead feed tanks, condensers, oil separators and final storage tanks.

Equipment is provided for the mixing of various tars for the production of road surfacing material, paints, and flooring and roofing, compounds, and the complete installation is arranged to enable tar to be easily handled and operated during the very coldest weather.

The Pipe Lines Underground Comprise :—

A drainage system of cast iron pipes varying from six inches to 14 inches diameter.

A six inch town water supply pipe, coupling up 16 fire hydrants.

A Standby—six inch diameter town water supply pipe for plant purposes.

Gas mains and connections varying from two inches diameter to 30 inches diameter.

Tar, ammoniacal liquor and steam pipes and electric cables.

The works are complete with a Workshop comprising :—Fitters', machine-, blacksmiths', electricians' and carpenters' shops.

The Offices comprise :—General, machinery and oil stores, Engineer's Offices, Drawing Office and an up-to-date laboratory.

Buildings comprising bath, dressing and mess-rooms are provided for the foreign and Chinese staffs.

Japan's Back to the Wall

(Continued from page 295)

of a strange land " of dwarfs," somewhere to the east, which he misspelled and mispronounced Japan, the island people, free from western problems of modern machinery and over-production, led a contented, balanced life.

Now, with desperate struggling, and such patience and industry as we can with difficulty imagine, Japan cannot support her 70,000,000, to say nothing of an increase of 7,500,000 every 10 years.

Every little patch of soil clinging to the sides of volcanic Japanese mountains is intensely cultivated and terraced to preserve the soil from erosion. Millions of Japanese find a living and food for themselves and other millions in the ocean. No fishermen are bolder, more enterprising, than the inhabitant of the innumerable Japanese fishing villages.

That mysterious entity " capitalism," against which Russia aims her weapons, presents problems in Japan. The average holding of the Japanese farmer is about an acre and a half. Seventy per cent of all farm families, living on these tiny patches of soil, are " tenant-farmers." They do the work but do not own the land, for which they pay extravagant rentals plus constantly increasing taxes

Let the American farmer try to imagine millions of Japanese farmers, averaging less than two acres of land each, trying to live, with nearly always large families, on about one-fifth the earnings of an underpaid Japanese factory hand.

Japan Aggrieved

On all sides the Japanese feel aggrieved. They conquered Russia, or, rather, they defeated the inept management of the Czars. But other Western nations would not allow Japan to profit by her victory. She could not chop off a rich, fertile section of Russia, as France recently did with Germany, for instance.

Japan has " seized " without much ceremony the lands of Manchoukuo, recently Chinese, but originally Manchurian, setting on the throne the former Chinese Emperor, legitimate heir to Manchuria.

And all Europe, which had concluded the Treaty of Versailles, robbing one nation the enrich another, gasped with horror. No wonder the Japanese believe the western world to be made up largely of hypocrites, even though they are too polite to say so.

Japan, over-crowded, her money depreciated, purchasing power abroad reduced to almost nothing, finds herself desperately situated in a world that has just finished a great war, with the great powers, having taken all they wanted, determined to keep things as they are in " the best of all possible worlds."

Japan Free to Act

Japan has been compared to " a trapped animal which has not yet lost its power to inflict terrible punishment on those who come near the pit into which it has fallen."

Japan, because of differences in race and racial antagonism among the less intelligent classes, is deprived of the right to spread over the earth as other races have spread.

But she is not in any " pit." The ocean of air is open to her flying machines and the other ocean to her submarines.

The western world, if wise, without sacrificing its racial or territorial integrity, will co-operate with the Japanese in their difficult problems.

It should be remembered that any future invasion of the west from Asia will not come creeping on foot or riding on small ponies, but flying through the air at high speed or with airplane-carrying submarines below the water.

From Tokyo Japanese airplanes can strike Russia's Vladivostok in six or seven hours, and before ten millions shall have been added to Japan's dense population it is certain that the Atlantic and Pacific oceans will mean no more in the way of defense than does now the English Channel that once " made Britain secure."

It is important that the western world should understand Japan's problem and discuss it with intelligent sympathy.

Malayan Tin Dredging's Latest Dredge*

One of the largest dredges in the world is the No. 1 dredge of Malayan Tin Dredging, Ltd., operating near Batu Gajah in the Kinta Valley. The Engineering Association of Malaya recently inspected this dredge, particulars of which it may be interesting to compare with other modern dredges operating in the F.M.S., which have from time to time been described in *The Mining Journal*.

The subjoined block shows the general elevation of the dredge, together with the chief dimensions.

This dredge was put into operation in 1931 and has been producing regularly ever since. It was designed and constructed by Messrs. F. W. Payne & Sons and has the largest bucket capacity of any dredge in the country. It is electrically driven, the power being supplied by the Perak River Hydro-Electric Power Company, Ltd. The current is delivered through a three core armored cable at a pressure of 3,300-volts, and transformed down to 415-volts and distributed to the various motors. Condensers are installed on board to correct the power factor which is maintained at approximately .9. The total horse-power of the motors installed is 1,050 h.p. The dredge is fitted with 16 cu. ft. buckets and has a maximum digging depth of 80-ft. The theoretical digging capacity is 711 cubic yards per hour. The pontoon is 210-ft. long, 60-ft. beam and 12-ft. deep and has a well length of 125-ft.

Ladder.—The ladder is 147-ft. 0-in. long between centers of upper suspension shaft and lower tumbler, and is 8-ft. 6-in. deep at the center. It is fitted with diagonal bulkheads spaced 3-ft. 0-in. apart. The lower tumbler bearings are carried in the jaws of a heavy box section steel casting rivetted securely to the top, bottom and side plates of the ladder effectually preventing spreading of the jaws. The jaws have extensions or "horns" following the line of the tumbler flange which assist in keeping the bucket string from riding completely over the tumbler flange. The ladder rollers are spaced 6-ft. 6-in. apart. They have chrome alloy shells 20-in. diameter wedged on to the shaft and bosses with wooden wedges. The shafts are $5\frac{1}{2}$-in. diameter and run in grit-proof trunnion bearings fitted with cast iron bushes and packing glands.

Buckets.—There are 106 buckets of manganese steel fitted with manganese steel lips. They have a capacity of 16 cu. ft. and eye centers 3-ft. 6-in. They are fitted with forged nickel chrome molybdenum steel pins with "L" heads and machined to a diameter of $7\frac{15}{32}$-in. The bushes are of half-round type and are of manganese steel. A few of the buckets are fitted with one full round bush. The bush is ground on the outside diameter and driven into the ground eye of the bucket. The bush is held tight by a tapered tyre steel key. The speed of the bucket chains is 70-ft. per minute and 20 buckets are tipped per minute. The weight of one complete bucket unit is 37 cwts. The lower tumbler is the "solid" type with cast steel body forced on to the shaft and fitted with hard cast steel tread plates in segments and manganese steel flange plates. The tread is 6-ft. 0-in. diameter and the flange is 8-ft. 0-in. diameter. The shaft is fitted with cast steel sleeves shrunk on and runs in cast steel bearings lined with cast iron bushes. The bearings have grit-proof packing held in with cast steel glands. The weight of the tumbler complete is 20 tons. The upper tumbler has a cast steel body keyed on to a mild steel shaft and is fitted with manganese steel tread and flange plates. The "heel" of this tumbler projects further than in previous ones and gives better support and longer grip on the bottom of the buckets riding on the tumbler.

Hoisting Gear.—The ladder winch is of the double hoist type and is driven by a 110 h.p. motor. There are two sets of six-sheave blocks for upper and lower gear. The sheave pins are of nickel chrome steel 9-in. diameter and the lower sheaves have grit-proof packing held by clamps. The hoisting rope is 5-in circ. and has a speed off the barrel of about 60-ft. per minute. The time taken to raise the ladder from the maximum dredging depth to the surface is 15 minutes. The total weight of the ladder line with the ladder in its highest position and the buckets loaded with spoil is about 400 tons.

The bucket drive is from a 300 h.p. motor through a countershaft on deck to the upper tumbler gearing. The belts are 36-in. wide and are 10 ply "Vi-balata super dredge" quality. The belt speed is 3,700-ft. per minute. The upper gearing is of the usual double drive type through a 54-in. Seymour clutch. The bearings are cast iron lined with white metal except the tumbler bearings which have gun-metal bottom halves and cast iron covers. The crown wheels are 15-ft. 6-in. diameter and the speed of the tumbler is $3\frac{1}{3}$ revolutions per minute.

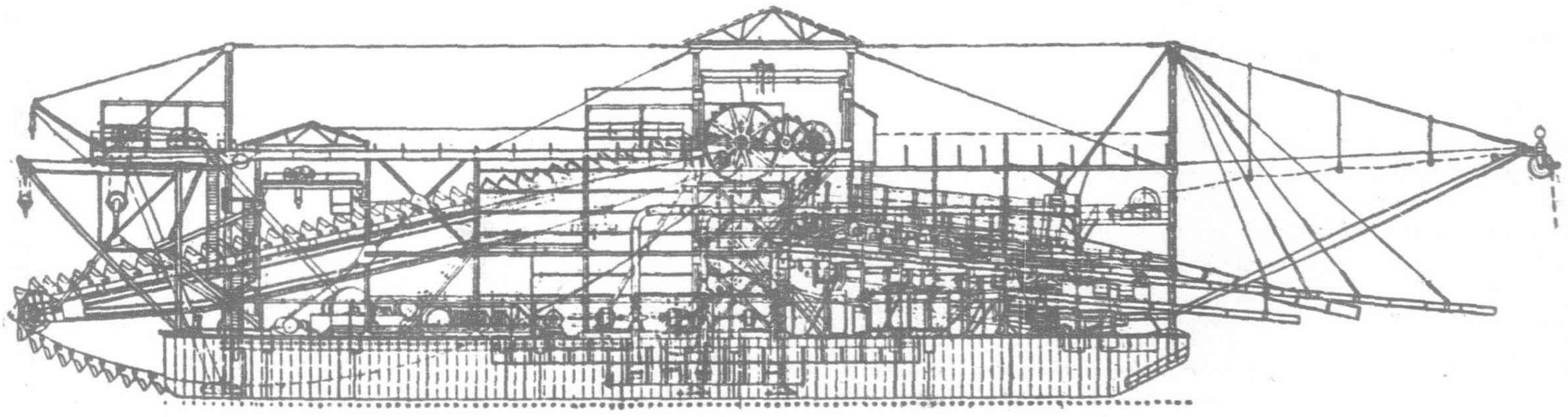
Screen.—The screen is of the double shell type with high carbon steel liner plates. The diameter is 8-ft. 0-in. and the total length of perforations is 42-ft. 0-in. The perforations are $\frac{1}{4}$-in. diameter and $1\frac{1}{4}$-in. pitch. The screen makes 6.3 revolutions per minute and has a slope of 1 in 12. The screen motor is 72 b.h.p. and the drive is by the usual friction roller through bevelled gearing and counter shafts.

Jigs.—There are 20 primary jigs and two clean-up jigs of the usual Hartz 4-cell type. Each jig is driven direct by a 4 b.h.p. motor with a 5 b.h.p. motor on the clean-up jigs. "Fabroil" pinions are used for the drives. The primary jigs run at a speed of 110 strokes per minute and the clean-up jigs at 180 strokes per minute. The jig cell beds are 4-ft. by 3-ft. and the sieve plates have $\frac{1}{2}$-in. by $\frac{3}{32}$-in. perforated slots running the long way of the cell.

The distribution from the screen hopper to the jigs is regulated by baffles suitably placed in the hopper. The screen hopper is

**The Mining Journal*

No. 1 DREDGE—MALAYAN TIN DREDGING, LIMITED.



Pontoon	.....	Length Moulded	210′ 5″
,,	.....	Breadth	60′ 0″
,,	.....	Depth at Well	12′ 0″
Ladder	.....	Length	147′ 0″
Buckets	.....	Capacity	16 Cu. Ft.

continued beyond the lower end of the screen in the form of a tray from which the feeds to the lower jigs are taken off. This tray is open and easy of access so that the baffles may be arranged and the lower jigs fed evenly without difficulty.

Concentrates.—The concentrates from the upper jigs are fed direct through a de-watering box to the clean-up jigs which are on the level. The concentrates from the lower jigs flow into a sump and are elevated to the clean-up jigs by a 4-in. Gwynne's sand pump. The product of the end cells of the clean-up jigs is elevated for re-treatment by a 55-in. by 8-in. centripetal pump.

Pumps.—The water supply is maintained by three Allen centrifugal pumps direct driven by motors and mounted on deck. The sparge pump is 18-in. bore and pumps 5,000 gallons of water per minute. The sparge pipe is triangular in section and is fitted with 175 nozzles $\frac{3}{4}$-in. bore. The motor is 125 b.h.p. The upper jig pump is 20-in. bore and pumps 7,000 gallons of water per minute. The motor is 125 b.h.p. The lower jig pump is 18-in. bore and pumps 5,000 gallons of water per minute. The motor is 70 b.h.p. A 5-in. Gwynne's vertical spindle bilge ejection pump is fitted in the pontoon.

Clay Extractor.—A clay extractor is fitted to engage the buckets as they are about to tip over the upper tumbler. A revolving tine with three cast steel arms shod with manganese steel spades is mounted on a rolled steel carriage suspended at one end from the dredge framing. The lip of the oncoming bucket engages with the projecting arm so that the tip of the spade is constrained to follow the curve of the bucket back. When the arm has completed its dip into the bucket and is released, the arm following is quickly brought into position for the next bucket by the action of a rolled steel setting frame hinged to the carriage which engages with triangular cams mounted on the tine shaft. The unsupported end of the carriage is connected through a wire rope to a dashpot. The extractor may be raised clear of the buckets when it is not required.

Cranes.—A 12 ton, three motor, overhead electric travelling crane arranged for cage control with a span of 20-ft. and a height of 30-ft. (from deck to rail centers) is fitted on the forward end of the dredge and is used for changing buckets and such work. A 20 ton overhead hand power travelling crane runs over the main gearing and a similar crane of 10 tons lift is over the winches. Two 20 ton jib cranes are fitted at the bow to deal with timber and lift the lower tumbler when changing or repairing it.

The new and the old No. 1.—In conclusion it may be of interest to compare, as a record of the progress in dredge design, this dredge with the original Malayan Tin Dredge No. 1 which it replaced. The old dredge began operations just over 20 years ago and was the first tin dredge in Malaya. It had 10 cu. ft. open connected buckets built up of mild steel plate. It was steam driven with 300 horsepower installed. Palongs were, of course, used for tin recovery. It dredged to 50-ft. 0-in. and had a theoretical capacity of 266 cubic yards per hour. The whole dredge weighed less than 500 tons, just a little more than the ladder, ladder fittings and bucket string of this new dredge. The original ladder on the old dredge weighed 20 tons as against 130 tons on this dredge, the lower tumbler three tons compared with the present 20 tons unit and the screen was only 5-ft. 6-in. diameter and $8\frac{1}{2}$ tons weight as against present 8-ft. 0-in. diameter screen weighing 35 tons.

Tanna Tunnel to Open

The Tanna tunnel will be opened for traffic on December 1, 1934, simultaneously with a speeding up throughout the whole Government railway system, according to the decision recently reached by the Railway Office.

The work of lining the tunnel with ferro-concrete has been going on steadily since the final obstacle was removed last fall and to-day there remain only 60 feet unlined near the center. This lining work is expected to be completed early next month, about the 16th anniversary of the commencement of construction.

The work of laying double tracks and of stringing overhead trolley wires, which will begin as soon as the entire five mile stretch has been lined with cement, will be finished by the end of September.

For two months, beginning October 1, test runs of trains will be conducted over the electrified stretch between Atami and Numazu. At the same time, the present Atami line, extending from Kozu to Numazu, which will replace the Gotemba detour on the completion of the tunnel, will be laid with new 100 lb. rails. Numerous improvements are also to be made at the Kozu, Kamonomiya, Nefukawa, Yugawara, Atami, and Numazu stations. These items alone will cost some Y.1,000,000.

A good sized tract of land near the eastern portal of the tunnel at Atami will be converted into a park, through funds subscribed by railway engineers and trackmen connected with the construction of the tunnel.

In a corner of the proposed park will rise a monument to be dedicated to the pioneers of the construction work and the workers killed in accidents. Thus, this five mile bore, representing a total outlay of Y.26,000,000, will be ready for traffic 16 years and nine months after the first pick was wielded.

Continental Tube Cartel

Negotiations which have lately been conducted between the International Tubes Association and the tube manufacturers of Japan through the intermediary of the French group of the Continental Tubes Association have now, according to reports from industrial circles in the Rhineland, been brought to a conclusion.

Under the new agreement, reports the Frankfurt correspondent of *The Times Trade and Engineering Supplement*, the markets of Japan, her colonies, and Manchuria are in principle to be left to the Japanese works, but the International Tubes Association has the right to continue to deliver certain qualities of tubes there in the case of Japanese requirements exceeding a certain minimum limit. The Japanese manufacturers are bound regarding the quantity and prices of their tube exports. The export quota allotted to them is said to be relatively small, with the result that the exports of the members of the International Tubes Association will not be adversely affected to any noteworthy degree.

The new arrangement with Japan is regarded as a considerable success in the German tubes industry, especially as the other foreign producers will not be excluded from the Japanese tube market and the fixing of prices will put an end to the heavy pressure hitherto caused by Japanese competition in the Far Eastern tube market. The agreement, which is to be in force until the middle of 1937, and can be denounced by either party from 1935 onwards on six months' notice, is said to relate only to gas tubes owing to Japan's hardly having started producing boiler tubes yet. However, it is believed that in the event of an expected expansion of Japan into that line of production the new agreement will also form a suitable basis for an agreement concerning boiler tubes.

Road Construction in Japan

Public works officials have met in Tokyo to discuss the ambitious road construction program which the nation intends to carry out in the next 20 years at a total cost of Y.730,000,000. The belt highway just completed at Tokyo was started in 1922 and has cost Y.35,000,000. The road is 24 yards wide and has a length of 20 miles. The first great road project was started in 1919 and cost Y.115,840,000. The new program is to begin in the next fiscal year. According to the draft scheme Y.448,768,000 is for improvement of national roads in existence. The total length of those is 6,903 kilometers. The national roads are to be widened to 7.5 meters in principle, but where traffic is congested, the roads will be 15 meters wide. In Tokyo and major cities, the width may be extended to 27 meters. All national roads are to be paved. Authorities plan to avoid surface crossings of railway lines. In principle, width of bridges on national roads is to be the same as that of the roads, but in the case of a long bridge the width may be reduced to a minimum of six meters, of permanent construction. About Y.8,400,000, the *Asahi* says, is to be appropriated for improvement of special national roads. There is about 380 kilometers of that type, and the Government proposes to improve about 275 kilometers. The Government plans to subsidize local administrations to the extent of Y.206,267,000 under the program, one-third the total expense. Proposed appropriations by years follow :—Y.32,030,000 for 1934 ; Y.32,030,000 each for 1935, 1936, 1937 and 1938 ; Y.36,220,000 for 1939, 1940, 1941 and 1942 ; Y.36,228,000 for 1943 ; Y.36,780,000 for 1944, 1945, 1946, 1947 and 1948 ; Y.41,000,000 for 1949, 1950, 1951 and 1952, and Y.40,982,000 for 1953.

From Junk to Yacht*

A Diesel Engine Fitted into a 32-ft. Taipu Junk

In China one expects to find anomalies, and a curious but eminently practical combination of East and West is the recent work of a Hongkong yachtsman who has furnished himself with an excellent fishing yacht, using as a basis for this conversion a 32-ft. Taipu junk which measures 27-ft. on the waterline and has a beam of 9-ft.

Au Chow Chi Hung (" Pride of Asia ") as the boat is named, has nothing incongruous in her appearance, for the owner has obviously taken pains to avoid spoiling the appearance of the boat notwithstanding that she is fitted with thoroughly modern accommodation. In addition, the craft is provided with a fishing platform forward, and this is equipped with a revolving seat and universal joint for a Hardy tunny rod.

In common with most craft of this type, the boat has no frames, and in place of these there were eight watertight bulkheads. In order to arrange the accommodation six of these were removed, and to maintain the strength of the hull these were replaced by 14 hard wood frames.

The cabin, which is 10-ft. in length, is built of teak, sliding windows giving excellent ventilation. At each side is a sleeping bunk, although seating accommodation for eight people is provided, together with plenty of locker space. The headroom in the cabin is 6-ft. 6-in. In addition to this accommodation there is a well-equipped galley and a toilet room.

One of the most interesting features of the boat is the extremely modern machinery, which comprises a two-cylinder 12/20 h.p. Ailsa Craig Diesel engine. This is a compact motor which takes up a small amount of space, but nevertheless it is capable of driving the boat at a speed of over 7 knots. Only 14 gallons of heavy oil fuel are carried; but this is sufficient for 20 hours' running at full speed; fresh-water tanks holding 120 gallons are also provided.

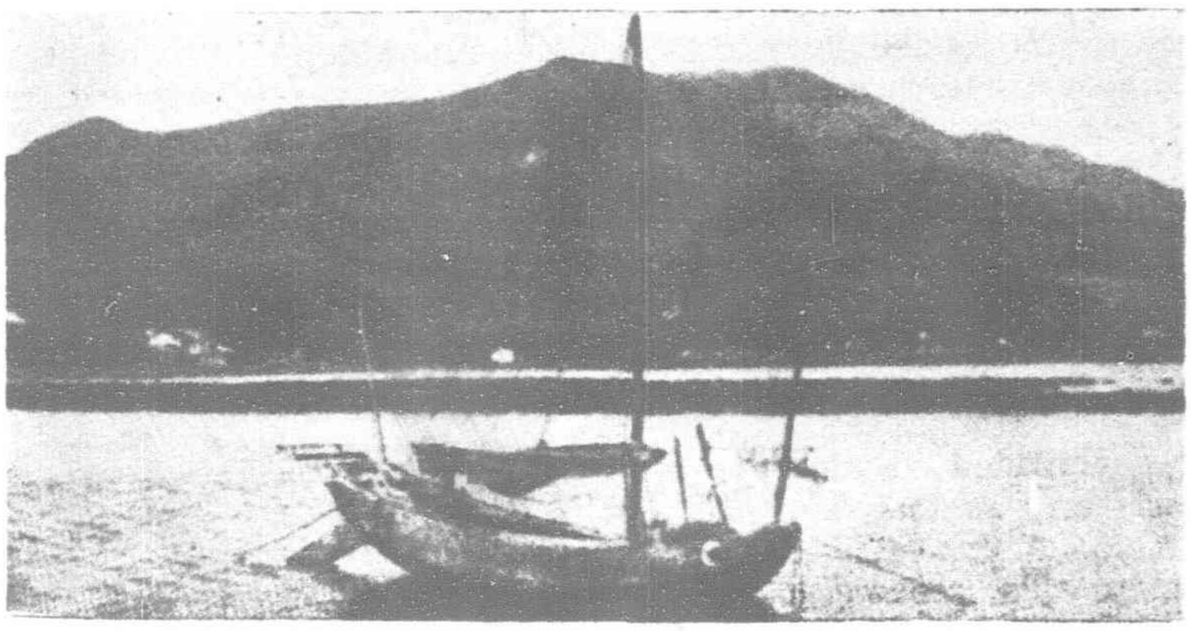
The original sail plan is retained; on the 35-ft. pine mainmast a battened junk sail of 6 oz. canvas is carried, having a total area of 770 sq. ft. The 16-ft. foremast supports a small sail of 87 sq. ft., while a European spinnaker of 221 sq. ft. is provided.

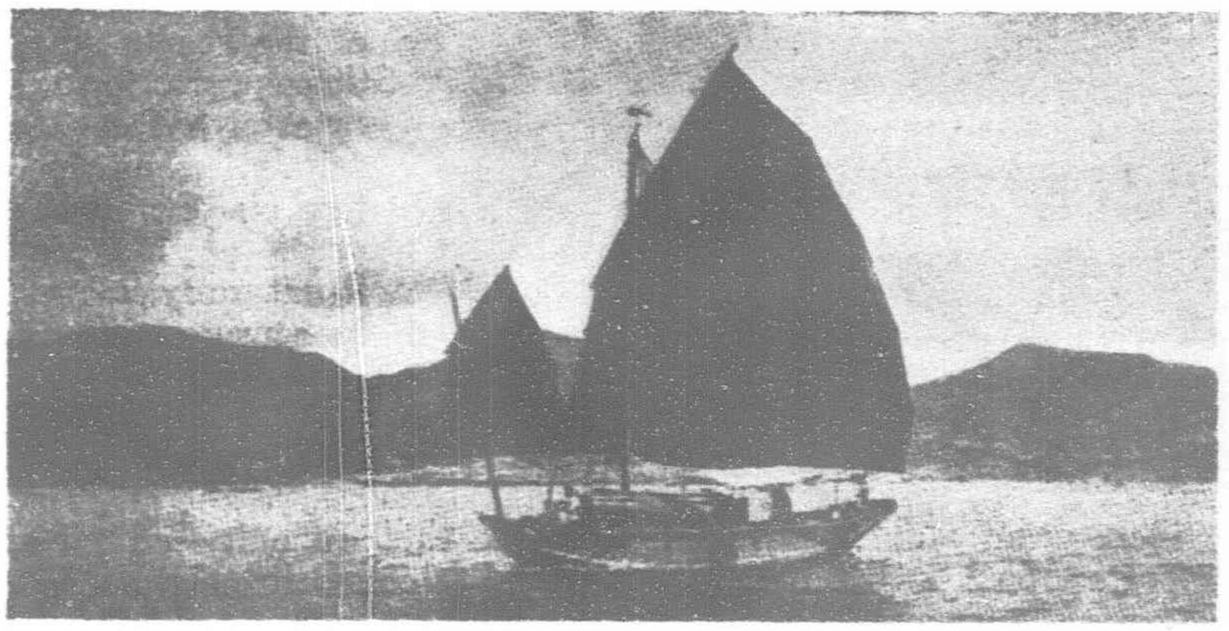
An alteration of importance is a substantial reduction in the great length of the original rudder; this has been made possible by bolting a heavy, hard wood keel to the boat, which has given better directional qualities. Another advantage conferred by the smaller rudder is that it need be raised no longer when passing over shallows; incidentally, this was a task calling for considerable strength, as the weight of the rudder fitted when the boat was purchased was no fewer than 4 cwt. From the battery, which is used to start the Diesel engine, the boat is also lighted, and supplies current for a flood light which has proved very useful for night fishing.

The performance of this boat has proved most satisfactory, and the sailing qualities so unimpaired that the craft has been entered for local yacht races.

A conversion of this type is of particular interest to those who do not wish to go to the expense of purchasing a new yacht. Although the cost of converting *Au Chow Chi Hung* has been considerably less than half the price of the machinery installation the work has been carried out in a thoroughly satisfactory manner, and is likely to lead to further conversions of a similar type.

**Eastern Engineering and Commerce*





Two Pictures showing the Craft at Hongkong

Colombo Port Trust Scheme

This question has been in abeyance ever since a committee, appointed by the Ceylon Government, had by a majority report recommended the formation of a port trust for Colombo two years ago.

The grounds upon which the project is being urged once more are reported to be :—

(1) That the interests of the port have suffered seriously in the past two years as a result of the depression.
(2) That many improvements are urgently necessary, and cannot be made under a system where port and harbor dues are credited to revenue ; and
(3) That, therefore, the early establishment of a port trust is urgently needed if the prestige and serviceableness of Colombo harbor are to be maintained in the face of the increasing demands of modern shipping.

It is urged by the interests concerned that a thorough overhaul of the whole port and its amenities should be carried out by an expert from England or India as a preliminary to the establishment of a port trust.

The methods of handling cargo, it is suggested, should be completely modernized by the introduction of the latest machinery for handling cargo. The existing warehouse accommodation is criticized on the ground of its being old, obsolete and unsuited to present needs. As regards the loss which general revenue would suffer by the formation of a port trust, various suggestions are made to meet it. According to the revenue estimates for the current year, the estimated revenue from port, harbor, wharf, warehouse and other dues is reckoned at Rs.5,310,000. The suggestion is that the lowering of the income tax basis to incomes of Rs.2,400 per annum and over would meet all or most of the deficit which would result from the allocation of port and harbor dues, etc., towards the funds of a port trust.—*The Dock and Harbor Authority.*

Engineering Notes

INDUSTRIAL

NEWSPRINT FACTORY.—Chinese sources state that the Ministry of Industries has found means of raising $3,000,000 for the establishment of a newsprint paper factory in southern Chekiang.

NEW RAYON FIRM.—The Myosho Rayon Company to be established by the Myosho Spinning Company, Osaka (capital Y.5,000,000), is to produce ten tons of staple fibre a day. Cellophane will also be manufactured shortly.

SODA PLANT FOR JAPAN.—The Tokai Soda Industry Company is to build a new soda factory at Koyasu, Yokohama, to produce soda by electrolysis. For this purpose, the company has purchased a large tract of land 15,000 tsubo at the Koyasu reclaimed ground.

MACHINES FOR CANTON—The Kuangtung Provincial Department of Reconstruction is contemplating making a contract with a Swedish company for the installation of machines, at a cost of approximately £199,611, for the paper factory which is to be established in the province.

JAPANESE CEMENT PLANTS.—The Osaka Ceramics and Cement Company is installing a new kiln capable of producing 14,790 tons a month. The Japan Portland Cement Company has decided to install a new 12,000-ton kiln at its Saeki plant. The present productive capacity is 41,220 tons a month.

ELECTRICITY IN JAPAN.—The Daido Electric Power Company has decided to build the Kasagi Power Station along the Kiso River, subject to approval of the Electric Power Federation. The company is building a generating station to be capable of developing 35,500 kw. Construction expenses are estimated at Y.7,800,000.

DOMAN-MARKS ENGINES — Doman-Marks Engine Co., manufacturers of direct air-cooled engines, Amesbury, Mass., are now producing three horizontal engines known as Models 6AH-309, 6AH-377 and 6AH-400. These develop 85, 104 and 111 horse-power respectively at 2,600 r.p.m. The special features are air cooling and a maximum over-all height of 26-in.

IN DUTCH NEW GUINEA.—The Dutch East Indies Government has introduced a Bill for the granting to the Bataafsche Petroleum Company, the Nederlandsche Koloniale Petroleum Company, and the Nederlandsche Pacific Petroleum Company of contracts for the exploration and working of oilfields in Dutch New Guinea. The combination includes both Royal Dutch and Standard oil interests, and the plans include the exploration of a surface area of 10,000,000 hectares, of which one million will be selected for exploitation.

JAPAN'S STEEL MERGERS—Resulting from a merger of the Government steel works and six independent iron and steel manufacturing concerns, the Japan Iron Manufacturing Company, Ltd. (Nippon Seitsu Kaisha) was formally founded on January 29. Its subscribed capital has been fixed at Y.368,490,000, the largest of any business concern in Japan. The merger of the Osaka Iron Manufacturing Company and the Tokai Steel Business Company is expected shortly. Negotiations are going on between the Showa Steel Manufacturing Company, Manchuria (capitalized at Y.100,000,000) and the Penchihu Coal and Iron Company, also in Manchuria, for a merger. With completion of a new factory in April, Showa Steel will be equipped to produce 400,000 tons of steel a year. Penchihu Coal and Iron are capable of producing 100,000 tons of iron and 500,000 tons of coal annually.

COMMUNICATIONS

HONAN-CANTON HIGHWAY.—The National Economic Council has urged the Highway Department to expedite construction of the Honan-Canton Highway. At present the roadbed from Ma Chia Chou to Shuichang has been completed, and other sections are under survey.

HAINAN DEVELOPMENTS.—It is officially announced that ten new harbours will be built in Hainan island, off the south coast of Kuangtung, as part of the plan of development. Meanwhile, measures are being taken to develop waterway communications in Kuangtung, these including the construction of docks and dredging operations.

SHANGHAI CIVIC CENTRE.—The request of the Greater Shanghai Municipal Government for the construction of a branch line of the Shanghai-Woosung Railway to the Civic Centre in Kiangwan has been approved by the Nanking Ministry of Railways. As the proposed line will run parallel with the San Min-road, it will not only facilitate communication but is expected to give great impetus to the development of the Civic Centre.

NANKING PROJECTS.—Hydraulic works and road-making projects involving an expenditure of $50,000,000 were discussed at a meeting of the Standing Committee of the National Economic Council at Nanking. A scheme for the development of the North-West envisaged the construction of 4,500 kilometres of new roads and the improvement of waterways. An extension of the road system and hydraulic works in seven provinces, an improvement of existing roads in Kiangsu and the construction of a motor road from Pucheng to Chanchow in Fukien were also discussed.

MITSUI IN MANCHOUKUO.—The Mitsui Gomei Kaisha is reported to have decided to invest Y.10,000,000 in Manchoukuo on river improvement, waterworks, emigration, water power for electric generation as well as other enterprises. The capital of the new State, Changchun, is to be made a metropolis with population of a million. A large reservoir will be built along the Inma River, 45 kilometres from Changchun. The company will undertake its construction, and plans to undertake the river's improvement, waterworks and hydro-electric power generation. A plan is also on foot to establish in Changchun a large warehousing company.

YANGTSZE BAR DREDGING.—The problem of removing 40,000,000 tons of mud from the Bar of the Yangtsze and lowering the crest by about nine feet over a width adequate for large ships, has been solved by the Whangpoo Conservancy Board with the construction of a special dredger in Germany. The dredger, when completed, will remove and discharge 30,000 tons in ten hours. In July, 1933, ten firms made offers, the most favourable being that of the German firm of Schichau, with a drag suction dredger. Its peculiar feature is that it travels under its own power at a speed of about two knots and scrapes its suction pipe along the bed. A powerful pump draws mud up the pipe and delivers it into special containers from which it may be discharged through doors in the bottom, or by pumping. The dredger now in course of construction is one of the largest that has ever been built, 360 ft. long, 60 ft. wide, and when loaded draws 18 ft. The contract price is £151,800. Mr. William Smith, the Board's dredging engineer, has been sent to Germany to collaborate with Lloyd's surveyor in supervision of the construction. It is expected that the dredger will arrive in Shanghai early next year. The question is being considered as to whether or not two dredgers of this kind will be required.

CANTON-HANKOW RAILWAY.—The Trustees of the British Boxer Indemnity Fund have approved the issue of a loan of £1,500,000 jointly by the Hongkong and Shanghai Bank and a group of Chinese banks for the purpose of completing the railway between Canton and Hankow. The loan will be at 6 per cent. and have 13 year currency, with amortisation during the last 10 years; and the security for the principal will be the Chinese share of the indemnity, which is nearly £300,000 a year. The negotiations with the banks, however, are not yet concluded on account of the fact that China declared a moratorium on the indemnity payments in 1932, and that since the moratorium expired she has allowed payments to fall into arrear.

TUNNEL TO REPLACE FERRY.—The slow-moving ferry across the Ajikawa, about three miles above the mouth at Gembei, is to be supplanted by a spacious Y.1,000,000 submarine highway tunnel about 18 months from now. The Osaka municipal civil engineering bureau will embark on construction during the middle of December. This submarine tunnel has been conceived by municipal engineers as the logical solution of the trans-Ajikawa traffic, which has for ages been carried by ferry boats. Although bascule and draw bridges were suggested from time to time they failed to convince the municipal authorities that they were the ideal medium, for the reason that approximately 2,000 craft of all sizes, including a great many 1,000 tonners, go up and down the river. The main bore beneath the river bed will be 80 metres long, and with the approaches to the river banks, the tunnel will have a total length of 130.7 metres. When the subterranean inclines from both sides are added, the entire length of the subway will extend 933.2 metres.

RIVAL PORT TO HONGKONG.—The Kwangtung River Conservancy Board has completed plans for the development of the projected ocean port for Canton at Whampoa. The plans provide for the gradual development of the port over a period of twenty years. The first stage will be construction of a harbour and godowns. An area of about 11,145 *mow* has been earmarked for this work. The present depth at Whampoa enables a ship under 5,000 tons to enter with ease, so that the port can be made use of as soon as harbour and godown facilities are available. The development of the port will then gradually be taken care of until it is provided with accommodation for ocean ships in accordance with plans laid down by the late Dr. Sun Yat-sen. The scheme also includes the laying out of a city. Different sections will be created for commercial, industrial, and residential purposes, and the city linked up with Canton by railway. In allowing 20 years for the realisation of the scheme, the committee hopes that difficulties connected with finance and other matters will be reduced.

AVIATION

SHANGHAI-HANKOW AIR SERVICE.—The schedule of the Shanghai-Hankow air mail and passenger service has been changed. The eastbound plane, instead of leaving Hankow at 8 a.m. each morning for Shanghai, will leave at 7 a.m., and the west-bound plane will leave Shanghai at 6.30 a.m. daily instead of 7, and the service will not be suspended on Mondays, as heretofore.

NEW AERODROME FOR HONAN.—Work on the construction of a new aerodrome, to occupy an area of 800 square metres, has been started at Chengchow. The District Government has despatched Mr. Wan Yu-heng to supervise the work, while surveyors have been provided by the Title Deeds Bureau to assist in the survey of the land. The aerodrome is to be completed in six months.